Engineering
Library

MAY 1922

Engineering News-Record

Devoted to Civil Engineering and Contracting
McGraw-Hill Company, Inc.

May 4, 1922

What is a Day's Work in Laying Concrete Pavement

A Study of 31 Contracts for 150 Miles of State Highways in Iowa

By H. K. Davis

Light-Weight Floor Construction

Details of Design and Construction of the Core-Type and Light Joist Floor for Buildings

By J. Fruchtbaum

Monthly Material Prices and Labor Rates

Engineering News-Record Construction Cost and Volume Index Numbers

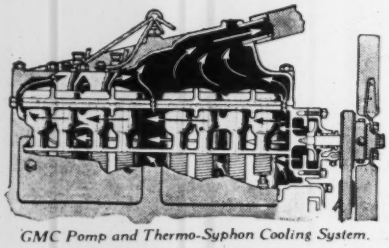
General Motors Trucks

One of the three GMC trucks operated by the Acme Sand and Supply Company, Atlanta, Ga.

These GMC Trucks Giving Fine Service Sixteen Hours Every Day

The Acme Sand and Supply Company of Atlanta, Georgia, purchased their first GMC truck in 1917. Two years later they added another GMC to their equipment. Then in 1920 they bought their third truck, which was also a GMC.

These trucks are kept at work on an average of 16 hours every day hauling sand, crushed rock and coal. On frequent occasions they are even kept in continuous operation for sixty hours at a stretch.



GMC Pomp and Thermo-Syphon Cooling System.

In commenting on the splendid service which these trucks provide continuously, Mr. K. M. Trowbridge, manager of the company, declares that although he had used practically all of the standard makes of trucks, before purchasing their GMC trucks he was never able to secure results from any of them which in any way approaches the service which is furnished him regularly by his GMC fleet.

Built As Users Want Them

Many other contracting and supply companies, both large and small, are securing just as excellent service with GMC trucks. This is for the reason that they not only embody in their design the most approved engineering practices, but every unit in their construction was considered as well from the standpoint of the actual user's needs.

What will it contribute to economy, dependability or convenience in actual service? Will it stand up well under the gruelling strain in continuous operation? Is it simple to care for? Is it easy to readjust or replace, so that the truck can be kept in continuous service? Such questions as these—points that are and always will be of vital importance to truck owners—were thoroughly determined before the final incorporation of any part. Consequently GMC trucks are built as users need and want them and are, as a result, many years in advance of general truck design.

In no other truck but the GMC will you find all these big economy features, such as the Two-Range Transmission, Removable Cylinder Sleeves, Pump and Thermo-Syphon Cooling Systems, Radius Rods, Removable Valve Lifter Assemblies, Pressure Lubrication and Instantaneous Governor — every one of which is indispensable to continuously satisfactory service.

Better in Even the Smaller Details

Then, too, you will discover even in the smaller details the careful consideration for the man who will own or drive the truck. All GMC engines are equipped with a high tension, waterproof magneto. The ignition system is simple, practical with no complicated network of wires to get out of order and is entirely separate from the generating system. The GMC clutch is troubleproof, requires no lubrication or adjustment. The brake rods and levers are so constructed that the brakes are interchangeable for either service or emergency purposes.

All models are equipped with electric lights and a large, powerful generator fitted with an automatic regulator. A starting motor is standard equipment on the one-ton model and can be easily applied to all other models as provision for its installation has been made. These are only a few of the many carefully planned features which translate themselves into a longer life of trouble-free service for the GMC owners.

Compare the GMC feature by feature and price for price with any other high-grade truck and you will then appreciate the substantial and enduring value it affords and why so many contracting and supply companies are standardizing on GMC service.

Know Your Trucking Costs

Only by knowing to a penny what it costs to operate your truck will you be able to realize the greatest returns on your investment.

We will be glad to send you a National Standard Motor Truck Cost System, adopted by the Truck Owners' Conference. No matter what make of truck you operate this system will keep your daily costs for one year. *Just send us this coupon attached to your business letterhead. There is no obligation to you.*

GENERAL MOTORS TRUCK COMPANY

Division of General Motors Corporation

PONTIAC, MICHIGAN

Dealers and Service in Most Communities

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—James H. McGraw, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. Mehren, Editor

Volume 88 — NEW YORK, MAY 4, 1922 — Number 18

Tulane In No Trouble

FROM a source whose accuracy has hitherto been unquestioned there was published in the issue of April 20, p. 666, a brief note stating that there was danger that the engineering and medical colleges of Tulane University might have to close for lack of funds. The statement appears now to have been unduly pessimistic for President Dinwiddie writes that both colleges are in excellent condition, that their funds, while modest, have been largely increased in the past two years and that there is not the slightest intention of closing either school. Tulane has so admirably carried forward the cause of technical education in the South that all engineers will be glad to know that it is not now in trouble.

The Colorado River Problem

FEW rivers have the potentialities of the Colorado. Flow and fall are both great and the surrounding country needs the power and the irrigation water that storage would develop. Furthermore in the lower river there is a serious flood menace, not to urban communities for towns there are scarce, but to one of the richest farm countries in the world. In few rivers likewise is the question of jurisdiction so complicated, for not only does the Colorado flow through seven states with conflicting demands as to relative priority of irrigation, flood prevention and power, but its outlet and much of its flood menace are in Mexico. Finally both utilities company and municipality have filed claims for power development on the river under provisions of the Federal Water Power Act. In the West most engineers know how great is the problem Mr. Hoover's commission is now trying to solve, but elsewhere there are probably many who have not appreciated that there is here one of the most ambitious, far-flung engineering schemes now in immediate prospect. To them the Reclamation Service report abstracted on another page is recommended as an admirable statement of the Colorado River situation as it is today.

Boosting the Barge Canal

ONE thing creditable to the St. Lawrence waterway will be admitted even by the New Yorkers who are so violently opposed to it. It has aroused the business men of New York and the state officials to the necessity of advertising the Barge Canal. That admirable waterway has been officially completed for some years but the growth of traffic along it has been disappointingly slow. The war, with its Government interference, and the post-war depression have together played havoc with predictions of tonnage carried so that the increase in use, while definite, has been very small. Now the various business organizations, alive to the Western propaganda for the international waterway, have decided that the state must show what its canal can do and that the people of New York, 90 per cent of whom live within 10 miles of the canal, must be educated to use it. Whether or not the Barge Canal is a successful substitute for a proposed deep waterway to the Lakes, it certainly has hitherto unused possibilities as a local carrier. In the interest of economic transportation it is to be hoped that these possibilities be quickly made real.

Fall Road Contracts a Failure

FALL contracts for highway construction, undertaken widely in response to the call by Secretary Hoover last September to relieve unemployment by encouraging winter work, appear to have shown almost none of the results anticipated by their advocates. In one or two states, of which Minnesota is the most striking example as noted in our issue of Feb. 9, 1922, p. 234, some construction of gravel roads has been carried out and in a few states a few contractors have accumulated stocks of aggregates for their summer operations, but, generally, there has been no greater amount of road construction during the past cold season than during any previous winter of the last few years. Even the promise that construction would be begun earlier in the spring, which there was some reason to hope might be realized, appears to have failed. Recent visits to half a dozen road-building states of the East have disclosed few contractors at work or even far advanced in getting their equipment onto the ground. The situation has been throughout the winter, and is now, about the same as if the usual procedure of calling for bids in March and April had not been varied. This outcome is unfortunate because it will tend to discourage effort in developing a really promising means of advancing the great road-building program of the country and of economizing in construction. It is an example of a useful idea too precipitately put into action. The way for so great a revolution in contracting habits and construction methods was not made clear before progress was attempted.

Motor-Vehicle Statistics for 1921

THE detailed figures on motor-vehicle registration in the United States for 1921, which the U. S. Bureau of Public Roads has just issued as a supplement to its preliminary announcement of a few weeks ago, offer an interesting field for analysis by the highway engineer. While the total of 10,465,995 vehicles for 1921 shows an increase of about 1,250,000 over the 1920 figures (see *Engineering News-Record*, April 21, 1921, p. 683), the *rate* of increase has fallen off. The total registration in 1921 was about 13.6 per cent greater than that of the previous year, as compared with a 22-per cent increase for 1920 as against 1919. The same relationship, however, does not hold for the commercial-vehicle classification, where a 22.7 per cent increase is shown by the year 1921 as compared with 1920 (last year there were recorded 1,033,151 commercial vehicles, including motor trucks, buses, and taxicabs) as against 841,690 in 1920, a gain of 191,461. This 22.7-per cent increase in commercial vehicle regis-

tration compares with a 12.7-per cent increase in passenger cars during the same period. In other words, the gain in commercial vehicles is progressing at a rate about twice as fast as that of passenger automobiles. This means, of course, that highways throughout the country are being subjected progressively not only to a numerical increase in total vehicular traffic but also to an increase of heavy loadings. Registration fees last year brought in $122,479,000 as against $102,034,000 during the previous year, a gain of $20,445,000, or about 20 per cent. The yield from registration and license revenues in 1921 averaged $11.70 per vehicle as against $11.08 per vehicle the previous year. In this computation for 1921 is not included almost $5,000,000 of revenue received from gasoline taxes in twelve states. Among the states, New York is the leader in total registration with 812,031 vehicles, made up of 630,791 passenger cars, 148,553 trucks and commercial cars, and 32,687 taxicabs and buses. In general, the statistics indicate forcibly the need for continuing policies of highway improvement and maintenance and an adequate and regular supply of funds for this purpose.

Using Old Canal Beds

A BYPRODUCT of the Barge Canal is the subway now being built in Rochester and described on another page. Only a few cities have abandoned canal beds but those who have are fortunate in being able to put to use for modern transportation facilities the abandoned facilities of an earlier day. Cincinnati some years ago started to do just this thing with a part of the bed of the Miami and Erie canal and now the abandonment of many sections of the old Erie canal offers similar opportunity to the large cities of the upper tier of New York State. Syracuse and Utica may be expected to follow Rochester, if not in subways at least in providing interurban entrances, boulevards in centers of congestion, or through-line sub-grade routes.

Funds Needed for Roads

MASSACHUSETTS is not alone among the states in facing a problem of financing highway improvements such as John N. Cole, commissioner of public works, outlined recently in the Boston *Transcript*. Looking ahead for ten years Commissioner Cole sees a need for raising $100,000,000 to be expended on 10,000 miles of road ultimately to form the state highway system, which at present includes 1,700 miles of improved road. A number of years ago Massachusetts discarded the principle of issuing long-term securities for highway improvements so that new funds must be supplied either from an annual appropriation added to the existing state tax or from increased vehicle fees. In the belief that the state, at present, cannot stand the burden of an increased state tax, the Department of Public Works has recommended to the legislature a higher scale of motor-vehicle fees. Many legislators, faced with the necessity of providing increased funds for roadbuilding, are turning toward the motor-vehicle operator with demands to carry the burden. This practice, followed blindly, is apt to result in great abuses. In the case of the Bay State, however, a comparison of the existing scale of vehicle fees with those in other states and with the schedule recommended in the proposed uniform vehicle law by the representatives of the motor-vehicle interests, indicates the justice of seeking increased funds from this source. The small car in Massachusetts today pays only $10 and the larger passenger cars, $15, while the rates for motor trucks from 1 to 5 tons capacity range from $10 to $50. These rates are decidedly low, particularly when compared with the range in the uniform vehicle law, of from $20 for a 1-ton truck to $80 for a 5-ton truck. In other words, Massachusetts, at present, is failing to receive from the motor-vehicle interests a considerable portion of the revenue which those very interests have conceded to be equitable. This journal has never been an advocate of making unreasonable demands upon motor users for highway development. It has maintained, however, that the scale of fees should be at least as high as those recommended in the uniform law. The facts in the case under consideration indicate a clear-cut case for increased revenue from the road users.

The Impending Catastrophe

DESPITE the depths of frightfulness plumbed during the war we have, it appears, to suffer even more grievous affliction. Submarines and poison gas are but mild irritants alongside the dose now brewing for the chastisement of the American people in general and of someone in particular—whom, we have not yet been able to make out. The trades unions are planning to boycott baseball. Last June Judge Landis was arbitrator in a wage controversy between the building workers and contractors of Chicago. His award was accepted by the contractors and twenty-two of the unions. Ten unions rejected it. The errant ten would now have the controversy reopened and have asked the presidents of the two major leagues to release Judge Landis long enough to do some more arbitrating. Failing this, the president of the Chicago Building Trades Council warns us, baseball is to be "spurlos versenkt." This really is going too far. The obdurate Judge should be made to see the light. He must be made to see it. In the name of humanity, page Babe Ruth!

American Construction Council—An Opportunity

EVER since the war there has been felt the need for some body that would draw together, for furtherance of their mutual interests and of the welfare of the public, all the groups that make up the construction industry. There have been various attempts to accomplish this result, but they have failed to win the wide support needed for a successful national movement. Now, however, there is put before the construction industry a plan that offers equal representation to all groups, that does not disturb group or association autonomy, that merely unites them for the furtherance of their mutual interests and that starts from the solid basis of squaring its every action with the public interest. The American Construction Council is the body—laid out according to that plan.

Its chance for success is excellent. In fact, it must succeed, for if it fail after sincere men have unavailingly tried their hands at other plans, then will be a discouragement that will be insurmountable in years and that will leave this tremendous industry a prey to the inefficiency against which even a long suffering public is reacting. But the times are propitious for launching an all-embracing movement. All who have been active in the previous attempts are parties to this

new effort. These workers include officers of the National Federation of Construction Industries, of the Building Congress movement, which has borne such excellent fruit at New York, Seattle and Portland, Ore., and of various groups, such as those at Philadelphia and Rochester, N. Y., which have worked on less elaborate plans. Furthermore, all the major interests, except labor and public utilities construction departments were ably represented at Cleveland, and both of the absent interests have given such hearty informal approval of the plan that there is no doubt of their adherence. Finally, the building-trade disclosures in various parts of the country, and the pressure for home building bring a demand from the public that the industry pull itself together and eliminate abuses and inefficiencies which are retarding the home-building movement.

The plan formulated at Cleveland appears to us a good one. It makes for a truly representative association. It prevents the dominance of any one group. It functions only where there are mutual interests; it deprives no group of its own distinctive work, but takes over only the common tasks. That these tasks are many need not be emphasized here. These columns have often pointed them out.

Engineers are now called upon to discharge an important civic duty by joining the new council and whole-heartedly supporting its efforts. The Federated American Engineering Societies will doubtless join, but this organized support must be supplemented by widespread and hearty approval by individuals, by the sacrifice of time in committee work and, for those who can do so, by financial support through the taking of sustaining memberships. There is here not merely a civic responsibility, but a civic opportunity. It is in the latter light, particularly, that we hope engineers will view it.

Lost Time Menaces Highway Progress

HIGHWAY contracting has little to be proud of in the manner in which it utilizes the brief season when, in the northern states, it can build concrete roads. Astonishing figures are given in this issue of the small average progress. It is less than 300 ft. a working day. The moderate proportion of time worked is even more astounding. In 114 calendar days there were only 96 working days. Work was actually performed on only 74 days and only 55 full days were worked, calling every day a full day if the lost time was less than three-quarters of an hour. Truly, lost time appears to be the distinguishing characteristic of concrete road construction as this operation is disclosed by the remarkable figures from Iowa.

It is not faulty technique of construction which makes progress slow, but pure waste of possible working time. In Iowa in 1921 work was performed on only two-thirds of the calendar days of the working season. Eliminating Sundays and holidays from the computation, only eight of ten working days were utilized in actual construction. Of the two idle days in every ten working days, one and one-half days were wasted because of rain, snow or mud. In comparison, all that a contractor can do to eliminate delays in moving equipment or from break-downs, and to keep the supply of materials constant, is a small matter. His only possible chance materially to cut down time lost is to devise means for reducing the hazard of bad weather.

No actual information is available how to reduce the hazards of rain, snow and mud in road construction. Even speculation appears to have been largely denied the subject. In concrete building, the hazard of cold weather has in recent years been met very effectively by housing and heating. Is the same safeguard not possible in road construction? Certainly the question is worth attention. Housing is not so impossible a task if one thinks of it. Canvas-covered frames are now universally employed to shield the green slab from the sun and rain. This is virtually a housing device. What is to prevent it from being extended to cover the finished grade? Is it not possible to contemplate the housing of even the grading operations. Shelter-tenting a half mile of road grade is not a stupendous task.

Besides sheltering the work from bad weather, there is the less remote possibility of devising wet-weather methods and equipment. There is not now a concrete road-construction method all of the units of which are designed to operate independently of the moisture conditions of the road grade. Perhaps the method which most nearly approaches the requirement is industrial railway haulage of wet batches. Improvement of industrial railway to make its operation independent of wet grade is a possibility. Safe modifications of the required condition of the subgrade, with respect to wetness, for receiving concrete, are other possibilities. The enumeration could presumably be continued, but the purpose here is to indicate the advantages of developing wet-weather methods rather than to specify in which way development is practicable.

In Iowa last year 15 per cent of the calendar days' period of work were lost because of wet weather. As last year's road builders will recall, there was no excess of rainy weather. The season in fact was rather exceptional for its weather favorable to construction. A season not remarkably bad would raise the proportion of rainy days to 20 or 25 per cent. This is the broad margin of waste which may be narrowed down by wet-weather construction methods. Could it be trimmed even a quarter, more time would be saved than if all delays due to faults of equipment and operation were completely eliminated. Obviously this is a gain worth seeking.

Whatever it may be practicable to accomplish in reducing wet-weather delays, there is an indictment of construction engineering in the broad assertion that if there had been no delays, a season's roadbuilding in Iowa could have been done in two and a half months. Iowa contractors are no more dilatory, probably, than those of other states and its conditions affecting the progress of road work are not greatly different, so that its experience is probably reasonably representative of general practice. Let us put the facts bluntly: There is no concrete roadbuilding for six months from October to May and the six months from April to November are occupied in doing two and a half months' work. What can roadbuilding say of itself as a business or as a technical accomplishment in the face of such a statement?

It was stated in *Engineering News-Record*, Dec. 8, 1921, p. 925, that contracting was failing to develop the technique of road construction and in the succeeding issue of Feb. 2, 1922, p. 177 that highway engineering was registering a similar failure. Can they deny the criticism, with the figures quoted in this issue, confronting them?

What is a Day's Work Laying Concrete Pavement?

Construction Progress on 31 Contracts by 19 Contractors Using 29 Outfits in 17 Counties in Iowa in 1921 Gives Answer—Shows How Small a Part of the Year Actual Work Is Done

By H. K. Davis
Chief Inspector, Iowa Highway Commission, Ames, Iowa

WHAT is a day's work for a concrete crew on highway paving work? Figures recently compiled in the office of the Iowa Highway Commission indicate that the custom has been to overestimate the capacity of a concrete gang; to make no adequate allowance for lost time, and finally, to over-rate the importance of large individual runs.

Average Conditions Represented—In 1921 a road-building program considerably larger than any previous year's output in Iowa, was put under contract and completed. The mileages of types other than one-course concrete were too small to give comparative figures of any particular value. Of this type, however, there were built 151.18 miles, some three times the amount built in any previous year. This furnished an opportunity to secure information regarding plant and organization efficiency by recording the daily progress made by the various contractors. Other reasons besides the increased mileage justified the data collected on 1921 performances as a basis for estimates.

1. The season was average in respect to weather conditions. Spring opened somewhat early and some concrete was laid by a few outfits, but any time thus gained was lost soon after by a late spring snowstorm, with continued bad weather. One or two outfits also operated later into the fall than is usually possible, but here again the equivalent of the time thus made available had already been lost by an early autumn snow. During the season a normal amount of rain fell, distributed in about the usual manner throughout the summer.

2. The season was normal in respect to labor supply. The few labor problems which arose, were occasioned by wages or working conditions and not by the amount of labor available.

3. The season was normal in respect to shipping facilities. Very few of the delays on account of materials could be charged to shortage of cars or other inadequate railway service.

4. A supply of concrete materials adequate to the needs of the work either existed or was developed for practically every job. A small number of outfits were at times held up for material, but this was unusual, there being no more trouble than in any normal year.

5. The paving laid was well distributed over the entire state and was therefore fairly representative of all conditions liable to be encountered in Iowa. A line drawn on a map around all the different paving jobs would include three-fourths of the area of the state.

6. The work done was well distributed as to size of individual jobs. The following statement shows that no great quantity of the work was bunched in any one locality nor went to one contractor: During 1921 work was carried on, on 31 contracts, by 19 contractors using 29 outfits on 35 separate sections of road under 26 road projects in 17 different counties. The term "outfit" is here used to include all loading, mixing and hauling equipment and their crews, which were operated as a single construction unit.

Method of Recording Results—The figures here summarized were compiled from daily inspection reports sent to the central office of the state highway commission by the inspectors on the jobs. These reports covered the day's run in considerable detail, locating it exactly by stations, and giving the usual information about cement content, subgrade, weather, and reasons for delays. They were sent in for each working day regardless of whether work was done. They did not show exact hours worked, therefore, the smallest unit of time was the day or fractional part thereof. Delays of 45 min. or under were not considered, they being too small to change the results materially. These daily runs for each job were checked carefully against the stationing and the length known to have been laid.

> IF THERE *had been no delays the whole season's work could have been done in 2½ months.*
>
> OF 35 *per cent lost time only 1.09 per cent was lost because of machinery breakdowns.*
>
> IN 96 *working days, work was done on only 74 days and only 55 full days were worked.*
>
> THE *record that an outfit can make once in a season is a poor criterion by which to judge the efficiency of the outfit.*

A tabulation was made by heading a column for each construction outfit, with a brief description of the work and the equipment used, following, in the body of the table, with the run in linear feet for each day until the job was completed. Runs by different contractors on any given date show opposite to each other on a single line. Reasons for failure to work on any day, or causes for delays were inserted in the same space as the daily runs, using a set of abbreviations in accordance with an attached legend.

General Inferences from the Records—Inspection of the table thus prepared discloses some interesting information. For example the effect of a state-wide or regional rain shows up immediately on the progress made throughout the state or region, on that date. Interesting comparisons appear between industrial railway and truck haul outfits, when the rains have not been too heavy. Also, nothing could be better than this comparison side by side to show the difference in the ability of the outfits to produce results consistently. *When two outfits work side by side, and conditions are similar and the weather is the same, and one outfit fails to work more than half the time while the other produces steady results day after day, the natural conclusion is that the difference lies in the management.*

The earliest outfit to begin work, laid concrete on April 8. The last concrete laid was on Nov. 16. Between these two dates there elapsed 223 calendar days, which, for this year, constituted the length of the construction season on paving. This is believed to be longer than could be depended on as a usual thing in this state.

The two longest-drawn-out jobs in the state were under way for 195 and 193 days, respectively. Neither of these outfits would have required this length of time to complete its work, however, had it not been for long delays due to weather, materials, etc. Several outfits, on the contrary, finished their undertakings in from 30 to 50 days. In some instances this would not have been possible except for the fact that the 30 or the 50 days happened to come between extended spells of bad weather. The effect of weather therefore is considered to balance up fairly well in the final averages.

Another factor is introduced by these short jobs that tends to modify the final averages in an unfavorable manner. This is that such a job does not constitute a season's work for the outfit. In some cases it is known that the outfit actually did other paving, perhaps on city streets. No data are at hand on their performance on any such outside work and it therefore cannot be considered by the highway commission. The record of the outfit as a consequence shows up poorly so far as the season's accomplishment goes, and brings down the average performance for the year for all the outfits. However, what is true of these outfits in an extreme degree is true in smaller degree of the majority of those on the state work during the year. Those outfits which are credited with doing a respectable season's work could in many instances have finished from one to three miles more of pavement if the work had been there to do. This is shown by the fact that the average completion date of all the outfits working was somewhere around Sept. 25, after which date there were several weeks of favorable working weather.

Any attempt, therefore, to regard the season's average performance per outfit as here shown, as the maximum possible output for such an outfit would be a mistake. At most it can only be regarded as what actually was done. And, since the conditions that caused it are not apt to change, it may safely be regarded as what probably would happen again in a normal season. The conditions mentioned are that in Iowa the length of road that can be included in any one contract is much more likely to be governed by the finances of the county paying for it than by the economical length of run for an outfit for the season.

Total and Average Performances—The data when tabulated were summarized (see accompanying table) to show total feet laid in the season, calendar days elapsed, actual days worked, total days delay due to various causes, etc. Averages were figured from these totals for each contractor and for the state as a whole. In spite of some small lengths of pavement held over from contracts let the previous year, and several current year contracts of from one to three miles only, the average length of pavement laid was 27,525 ft., or in the neighborhood of 5 miles. Several outfits laid from 40,000 to 50,000 ft. or from 8 to 10 miles. One outfit closed the season with 61,585 lin.ft. or 11.65 miles to its credit. This was a pavement of more than usual difficulty, having a 20 ft. width, integral curbs, monolithic street inlets, and many intersections and farm entrance returns. Figures in the tabulation are given in linear feet measured on the center line, since for the purpose in view this unit serves as well as any other. It was reported by the man in the field because of the considerable amount of work necessary to reduce stationing to square yards when the design included many widened curves, intersections, etc. For comparative purposes these would introduce but small variations, since they will average very nearly the same per mile of road. The width of all roads also was uniformly 18 ft., except in a very few instances where it was 20 ft. This fact furnishes an easy conversion factor for approximate calculations, 1 lin.ft. being the equivalent of 2 sq.yd. of pavement in nearly 90 per cent of the cases.

The average length of time used per outfit to complete the season's work was 114.3 calendar days. This is a decided decrease from the 180 to 200 days usually taken as the length of the working season on concrete paving. When the average feet laid per day is calculated, with calendar days as a basis, a figure of 241 ft. per day for the state results. This shows how small an average should be used in case it is ever desirable to use a calendar day average.

When Sundays and legal holidays are eliminated from the total calendar days a more logical basis of comparison is left. With the possible working days cut to an average of 96.1, the average output per outfit is raised only to 286 ft. per day, or less than 600 sq.yd.

Eliminating all rainy days and other stops leaves an average of 74.1 days per outfit on which concrete was actually laid during the season. Not all of these days were full days since many of them show only short runs when rain or break-downs stopped the work for the remainder of the day. To the highway commission and the contractors of Iowa it was a distinct surprise to find *that all the concrete laid in a season's work could have been concentrated in two and one-half months of steady work if only the causes for delay could have been eliminated.*

The average laid per day worked, also, is a very conservative figure, being 371½ ft. With a favorable season and everything practically normal, this figure would indicate that the assumption sometimes made that an outfit should turn out 800 sq.yd. per working day is at least ample for an average of good, bad and indifferent organizations. Some half dozen one-mixer outfits only were able to exceed this 800 sq.ft. average throughout the 1921 season in Iowa, and these outfits were the ones that were noticeable to even the casual observer for their ample equipment and good management.

The 74.1 average of days on which work was done represents 64.8 per cent of the average 114.3 days time elapsed during which the work was under way. One contractor's superintendent is known to the writer to have stated early in the season that 80 per cent of the time is the best that any one should figure on. The table shows that he came within 1.8 per cent of reaching this limit with one outfit, but to do this he worked many Sundays that others did not. The closest competitor this firm had in this respect worked 73.9 per cent of the time, and very few outfits reached 70 per cent.

Principal Causes of Delays—The remaining 35.2 per cent of the days not worked are classified under various

Contractor Location	Moore-Young Construction Co. Waterloo, Ia.	Moore-Young Construction Co. Waterloo, Ia.	Wm. O'Neil & Sons Earthauls, Minn.	Koss Construction Co. Des Moines.	Koss Construction Co. Des Moines.	Chas. Weitz Sons Des Moines, Ia.	Koss Construction Co. Des Moines.	Henkle Construction Co. Mason City, Ia.	Pickus Engineering Co. Sioux City, Ia.	Emmerson & Johnson Humboldt, Ia.	Whitlow Construction Co. Appleton, Wis.	Whitlow Construction Co. Appleton, Wis.	Marsh Engineering Co. Jefferson
	Benton Co.	Benton Co.	Cerro Gordo Co.	Clinton Co.	Clinton Co.	Des Moines Co.	Dickinson Co.	Cerro Gordo Co.	Hancock Co.	In City of Humboldt, Ia.	Floyd Co.	Floyd Co.	Greene Co.
Equipment	Central Prop. Plant. Foote 21-E paver. Auto Car Trucks. Erie locomotive Crane.	Central Mixing Plant. 1 paving mixer. Ford Trucks. Byers Crane.	Central Prop. Plant. Industrial Railway. Wooden Tunnel. Locomotive Crane.	Central Prop. Plant. Guy Derrick. Auto Car Trucks. Koehring Paver.	Central Prop. Plant. Jenny Wink Crane. Industrial Railway. Koehring Paver.	Central Mixing Plant. Smith Mixer. Steel Stiff Leg Derrick. Belt Conveyor. Paving Under Railway. Federal Trucks.	Central Prop. Plant. Stiff Leg Derrick. Gravel Plant in Connection. Auto Car Trucks. Koehring Paver.	Central Prop. Plant. Brown Hoist. Locomotive Crane. Wooden Tunnel. Industrial Railway. Koehring Paver.	Central Mixing Plant. Guy Derrick. Autocar Trucks and Others.	Central Prop. Plant. Paving Mixer. Truck Haul.	Central Mixing Plant. Rex Mixer. Truck Haul. Guy Derrick.	Central Mixing Plant. Double 2-Rex Mixers. Guy Derrick. Truck Haul.	Use 4 different Plants. 1 Central mixer. 3 Paving mixer. East and two Combined on Central mixing plant. W. Truck Haul on all cases. Stiff Leg Derrick.
Pavement	Width 18 ft. Center-8 in. Sides-7 in.	Width-18 ft. Center-8 in. Sides-7 in.	Width-18 ft. Center-8 in. Sides-7 in.	Width 18 ft. Center-8 in. Sides-7 in.	Width-18 ft. Center-8 in. Sides-7 in.	Width-18 ft. Center-8 in. Sides-8 in.	Width-18 ft. Center-8 in. Sides-8 in.	Width-18 ft. Center-8 in. Sides-8-7 in.	Width-18 ft. Center-8 in. Sides-8 in.	Width-22 ft. Center-8 in. Sides-7 in.	Width-18 ft. Center-8 in. Sides-7 in.	Width-18 ft. Center-8 in. Sides-8 in.	Width-18 ft. Center-8 in. Sides-7 in.
Total no. of linear ft. laid in season 1921	40,580	6,441	57,332	41,965	49,42	16,791	23,424	45,125	21,017	1,149	4,747	26,656	27,495
Calendar days elapsed from start to finish of work	191	18	137	137	155	195	137	131	90	16	31	75	111
Average ft. laid per calendar day	210	369	367	267	319	199	196	340	234	32	153	356	243
Possible working days from start to finish (ex. Sun. Holiday)	162	13	132	132	130	164	115	112	75	18	25	64	93
Average ft. laid per possible working day	247	495	436	318	380	236	221	376	280	58	190	262	259
Working days on which pavement was actually laid	101	26	115	101	109	100	73	94	64	16	15	53	61
Average ft. laid per day worked	402	247	501	399	453	295	349	480	329	72	316	541	450
Percent of all calendar days worked	52 3	65 4	73 3	66 9	70 3	66 7	53 3	70 7	71 1	44 4	48 4	70 7	55 5
Total Sundays and holidays from start to finish	31	5	23	23	25	31	22	21	15	5	6	11	15
Sundays and holidays on which no work was done	30	5	23	21	23	23	20	19	14	5	5	11	15
No. of whole days lost because of snow, rain and mud	51	7	17	18	12	25	19	14	8	2	11	10	10
No. of whole days lost because of breakdown plant	0	0	0	1	0	3	22	0	0	0	0	0	2
No. of whole days lost because of shortage of material	0	0	0	0	5	5	1	0	0	1	0	0	6
No. of whole days lost because of moving equipment	11	0	2	9	6	0	0	5	1	0	0	0	8
No. of whole days lost because of all other causes	0	0	0	1	0	5	2	1	1	12	0	1	9
No. of whole days lost because of total all causes	92	12	42	52	46	63	64	39	26	20	16	22	50
Percent of all calendar days lost because of S. & H.	15 6	11 2	14 6	14 6	14 8	11 8	14 6	14 1	13 5	11 9	16 1	14 2	11 4
Percent of all calendar days lost because of snow, rain, mud	26 4	18 4	10 8	11 3	7 8	14 4	13 9	10 5	8 9	5 6	35 5	15 1	14 2
Percent of all calendar days lost because of breakdown	0 0	0 0	0 0	0 6	0 0	1 5	16 1	0 0	0 0	0 0	0 0	0 0	1 8
Percent of all calendar days lost because of S. of material	0 0	0 0	0 0	0 0	3 2	4 1	0 7	0 0	0 0	2 8	0 0	0 0	5 1
Percent of all calendar days lost because of moving equipment	5 7	0 0	1 1	5 8	3 9	0 0	0 0	2 2	1 1	0 0	0 0	0 0	7 0
Percent of all calendar days lost because of all other causes	0 0	0 0	0 0	0 6	0 0	1 5	1 4	2 1	1 4	11 1	0 0	1 5	0 0
Percent of all calendar days lost because of all causes	47 7	31 6	26 7	33 1	29 7	33 1	46 7	29 1	28 9	55 6	51 6	29 1	44 2
No. of fractional days lost because of S. R. & M.	11	5	15	16	8	18	9	11	7	2	0	2	6
No. of fractional days lost because of breakdown	0	1	4	5	6	12	1	2	7	0	0	2	9
No. of fractional days lost because of S. of materials	0	0	0	1	6	11	6	0	0	0	0	0	2
No. of fractional days lost because of moving equipment	4	0	2	2	1	5	1	1	1	0	0	1	0
No. of fractional days lost because of all other causes	5	0	0	6	5	9	0	4	2	0	0	2	2
No. of fractional days lost because of total all causes	20	6	21	32	26	55	17	18	17	2	0	9	10
Percentage of days worked on which delays occur	19 8	23 1	18 3	30 5	23 9	42 3	23 3	19 2	25 6	12 5	00 0	17 0	15 9

heads according to the causes for the delay. The resulting percentages are as follows:

PER CENT OF ALL CALENDAR DAYS LOST

Sundays and holidays	14.20
Snow, rain and mud	14.70
Break-downs	1.09
Shortages of material	1.14
Moving equipment	2.56
All other causes	1.51
Total	35.20

Attention is called to the large part that Sundays and legal holidays and the weather play in the contractors' plans.

The small percentage of whole days lost on account of break-downs is rather noticeable. This speaks a good word for the reliability of modern paving equipment. It also speaks well for the foresight and push of many of the superintendents in having repair parts on hand and being able to place them quickly, for when the small delays due to various causes are tabulated and classified, break-downs make up a much larger per cent of the whole.

The percentage of days lost on account of shortages of material, bears out the statements made earlier, that the season was as favorable as could be expected as regards material supply and delivery.

The moving and re-erecting of equipment makes up a much larger percentage of all time lost than would have been supposed by most engineers.

"All other causes" for days lost, include shortages of water, shut-downs to prepare subgrade, shut-downs by engineer or inspector, labor shortages, truck shortages, etc. They are each one so small as not to justify separate classification.

The fractional days lost are classified under the same headings as the whole days lost except for Sundays and holidays. The tabulation is as follows:

PERCENTAGE OF FRACTIONAL DAYS LOST

Rain, mud and snow	12.41
Break-downs	5.21
Shortage of material	2.51
Moving equipment	1.58
All other causes	4.55
Total all causes	26.26

The figure of 26.26 represents the percentage of the days worked on which there was some considerable delay due to some cause or other. Subtracting this from the 74.1 days worked leaves 54.7 full-days work on which there was no delay of more than about 45 minutes.

The prevailing tone of the conclusions drawn from the tabulation appears to be pessimistic. The almost universal habit of engineers to give honorable mention only to their livest contractors; of contractors to mention only their best days run, and of equipment concerns to advertise only the job where their equipment proved highly successful, have all created false impressions of the possibilities of construction progress. *The record run that an outfit can make once in a season is a poor criterion by which to judge the efficiency of the outfit.* Yet the public, and to too great an extent the profession itself, have these figures in mind in judging a contractor's progress. Alongside such records the mediocre performance of the steady producer seems unromantic and uninteresting, but the fable of the hare and the tortoise is as true today as it was when first told.

Individual High Records—As evidence that the figures used in this article are not based on the performances of a group of lightweight contracting concerns, some of the individual records are appended. While these in no instance set new marks for the contracting fraternity to shoot at, it is believed that they show that the organizations which laid the Iowa pavements in 1921 were well organized and alive to the necessities of their jobs. This being true the figures here compiled are fairly representative and if not entirely applicable in other states, may at least be considered indicative when proper allowance has been made for the differences in basic conditions.

One outfit ran 1,200 lin.ft. of 18-ft. pavement in 19 successive working hours. Another outfit belonging to the same contractor ran 1,025 ft. in 16 hours. An outfit with two mixers in a battery ran 1,025 ft. in a ten-hour day. Another outfit ran 935 ft. of 20-ft. pavement in a

Cameron Joyce Smith Elder & Co. Keokuk, Ia.	Henry W. Horst Co. Rock Island Illinois	Wright Construction Co. Des Moines	J. H. Johnson Royal, Ia.	O'Rourke Engineering Co. Des Moines	O'Rourke Engineering Co. Des Moines	Capitol Construction Co. Des Moines	Capitol Construction Co. Des Moines	Brereton & Hauck Emmetsburg Ia.	O'Rourke Engineering Co. Des Moines	Thomas Carey & Son Des Moines, Ia.	Wright Const. Co. Des Moines Ia.	Lake & Mosher Sioux City, Ia.	Lake and Mosher Sioux City, Ia.	C. F. Lytle Sioux City, Ia.	C. F. Lytle Sioux City, Ia.	Totals	Averages	Percentages
Johnson Co.	Linn Co.	Marshall Co.	O'Brien Co.	O'Brien Co.	O'Brien Co.	O'Brien Co.	O'Brien Co.	Palo Alto Co.	Polk Co.	Polk Co.	Polk Co.	Sioux Co.	Sioux Co.	Woodbury Co.	Woodbury Co.			
Central Prop. Plant Paving Mixer, Ford Trucks Haul Loader	Central Mixing Plant Belt Conveyors Ford Trucks Koehring Mixer	Central Prop. Plant Stiff Leg Derrick Autos at trucks Foote Paving Mixer	Central Mixing Plant Using paving mixer and Barber Greene loader Truck Haul	Central Prop. Plant Wooden Bins Industrial Railway Foote Paving Mixer Locomotive Crane	Central Prop. Plant Foote Paving Mixer Ford Trucks, &c. others Byers Crane	Central Prop. Plant, Paving Mixer Truck Haul Erie Crane	Central Prop. Plant Byers Crane Paving Mixer Truck Haul	Central Prop. Plant Barber Greene Loader Industrial Railway Koehring Paver	Central Prop. Plant Foote Paving Mixer Ford Trucks Byers Crane	Central Prop. Plant Dragline Crane Paving Mixer Truck Haul	Central Prop. Plant Gas and Stiff Leg Derricks Foote Paver Truck Haul	Material Stockpiled on Subgrade Austin Paving Mixer Wheelbarrows	Central Mixing Plant Two Austin Paving Mixers on Batters Truck Haul	Central Prop. Plant Austin 21-E Paver Koehring Trucks	Central Prop. Plant, G. & S. Locomotive Crane Austin-21-E Paver Koehring Trucks			
Width 18-20 ft. Center 8 in. Sides 8-7 in.	Width 18 ft. Center 8 in. Sides 7 in.	Width 18 ft. Center 8 in. Sides 8 in.	Width 18 ft. Center 8 in. Sides 7 in.	Width 18 ft. Center 8 in. Sides 7 in.	Width 18 ft. Center 8 in. Sides 7 in.	Width 18 ft. Center 8 in. Sides 7 in.	Width 18 ft. Center 8 in. Sides 7 in.	Width 18 ft. Center 8 in. Sides 7 in.	Width 20 ft. Center 8 in. Sides 7 in.	Width 20 ft. Center 8 in. Sides 7 in.	Width 20 ft. Center 8 in. Sides 7-8 in.	Width 18 ft. Center 8 in. Sides 7 in.	Width 18 ft. Center 8 in. Sides 7 in.	Width 20 ft. Center 8 in. Sides 8 in. Curbs, Intakes & Returns	Width 20 ft. Center 8 in. Sides 8 in. Curbs, Intakes & Returns			
19,117	25,942	51,300	21,105	36,890	11,506	25,563	18,362	46,791	15,959	14,347	17,579	5,454	11,597	61,585	26,792	298,245	13,568	27,525
135	130	150	112	133	47	144	117	154	79	72	174	44	66	179	98	1,344	3,114	114.1
153	200	209	188	277	246	177	157	302	202	199	226	161	252	344	275			241.0
106	110	125	94	111	39	121	98	129	66	60	148	37	59	149	83	2,786		96.1
181	236	250	225	332	289	212	187	363	242	219	247	202	297	413	123			286.0
83	81	96	72	90	31	79	75	96	67	45	117	24	54	140	75	2,148		74.1
236	320	326	294	410	372	324	252	468	340	299	321	227	341	440	357			371.5
64.0	62.3	64.0	64.3	67.7	66.0	54	62.4	62.3	59.5	66.6	67.2	54.5	71.9	78.2	76.5			64.80
19	20	25	18	22	8	23	19	25	15	12	26	7	7	29	15	528	18.2	16.00
18	20	24	17	18	6	22	18	23	13	13	22	6	7	19	7	470	16.2	14.20
18	23	24	18	14	9	33	16	25	15	15	31	8	1	13	9	487	16.8	14.70
1	0	0	0	2	0	0	0	0	2	0	1	0	1	1	0	16	1.24	1.09
4	5	0	0	1	0	3	2	0	0	0	0	0	1	1	0	38	1.31	1.14
2	1	1	1	7	0	6	5	6	2	0	3	0	0	2	7	65	2.92	2.56
1	0	3	4	1	1	1	3	4	0	0	0	6	0	1	0	50	1.72	1.51
44	49	54	40	41	16	65	44	58	32	24	57	20	12	59	21	1,166	40.19	35.20
14.4	15.4	16.0	13.2	13.6	12.8	15.5	15.4	14.9	16.5	15.1	12.6	11.6	14.2	10.6	7.1		14.20	14.20
14.4	17.7	16.0	16.1	10.5	19.1	22.8	15.7	16.3	19.0	18.1	17.9	18.2	6.5	8.4	9.2		14.70	14.70
0.8	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	2.5	0.0	0.6	0.0	2.2	0.6	0.0		1.09	1.09
3.2	3.8	0.0	0.0	0.7	0.0	2.1	1.7	0.0	0.0	0.0	0.0	0.0	2.2	0.6	0.0		1.14	1.14
1.6	0.8	2.0	0.9	5.1	0.0	4.2	4.5	1.9	2.5	0.0	1.7	0.0	0.0	1.1	2.2		2.56	2.56
0.8	0.0	2.0	3.5	0.7	2.1	0.7	2.5	2.6	0.0	0.0	0.0	11.7	0.0	0.5	0.0		1.51	1.51
35.2	37.7	36.0	35.7	32.3	34.0	45.1	37.6	37.2	40.5	33.4	32.8	45.5	26.1	21.8	23.5		35.20	35.20
10	14	17	7	11	5	10	10	8	5	6	18	5	4	19	6	267	9.21	12.41
3	9	6	1	3	0	10	11	6	4	6	5	0	0	5	1	112	3.86	5.21
8	6	0	0	1	0	1	3	0	0	0	0	1	4	2	0	54	1.86	2.51
1	0	0	1	2	0	1	1	0	1	0	3	0	1	4	0	34	1.17	1.58
8	5	6	6	8	3	8	7	3	1	2	2	0	2	6	2	100	3.45	4.5
27	34	29	15	25	8	30	32	17	11	14	28	6	11	36	11	567	19.55	26.36
33.4	42.0	30.2	20.8	27.8	25.8	38.0	43.8	17.7	23.4	29.2	23.9	25.0	32.4	25.7	14.7		26.26	26.26

16-hour day, building curbs, gutters, intakes, and driveway returns, in addition. Runs of 700 to 800 ft. were common, while gangs whose regular daily output was from 500 to 600 ft. per day, when running well, were the rule.

One contractor between June 16 and July 30 inclusive, 45 calendar days, worked every day but the 7 Sundays and legal holidays, or 38 successive working days, laying in that time 20,658 lin.ft. of 18-ft. pavement 7 in. thick at the edges and 8 in. at the center. This was an average of 543½ ft. for every working day for a month and a half. Reduced to cubic yards it equals a daily run of two-hundred thirty-one and one half cubic yards.

Another contractor using two separate outfits, worked both outfits every calendar day for 34 successive days from Sept. 21 to Oct. 24 laying in this time 29,347 lin.ft. of 20-ft. pavement 8 in. thick, with integral curb and gutter. This was a total of 5.56 miles or an average of 432 lin.ft. per calendar day for each outfit. Reduced to cubic yards this made 218 cu.yd. per day per outfit. Not the least interesting features of this run was that a weighted average of the haul shows every ton of this material hauled a trifle over five miles. The bulk of it was hauled over a hill road containing seven adverse 6 per cent grades and many smaller ones. A large share of it was hauled up a single grade 9,000 ft. long, part of which was 6 per cent, and which had a number of curves. Practically all the remainder was hauled up a grade a mile long, with several curves and some 6 per cent grade. To complete his difficulties a move was necessary with one of the outfits. By bringing in an extra mixer the remainder of the equipment was moved 15 miles across country and 29 ft. of pavement was laid on the same day.

These accomplishments are not exceptional but they do show good management on the part of the contractors. Yet in spite of this they were able to run only 371 ft. per day for 74 days during the year.

Four Carloads of Lumber

THE accompanying photograph gives evidence of the size of Douglas fir trees which grow in some of the stands of timber owned by the St. Paul & Tacoma Lumber Co. The butt cut on the first car came from a tree which the report says was 300 ft. high and whose lowest limb was some 200 ft. above the ground. This log was 32 ft. long, 9 ft. in diameter inside the bark at the butt, 7 ft. at the top, and scaled 11,000 ft. b.m. The entire tree scaled 43,000 ft.

THE "BIG STICK" SCALES 11,000 FT. B.M.
The first log was 32 ft. long and 9 ft. in diameter at the butt end.

The second car in the picture contains the butt log from another good-sized tree and the other cars carry the second and third cuts, respectively, from the larger trees. The photograph was taken in January at the plant of the company in Tacoma, Wash., just before the logs were dumped in the pond.

Stanford Stadium Built of Timber on Earth Fill

Material From Site Cut 23 Ft. to Form 37 Ft. Fill—Shrinkage Nominal Due to Tamping by Animals and Equipment

By E. E. Carpenter
Of Baker and Carpenter, Engineers, San Francisco, Cal.

THE athletic stadium completed last fall for Leland Stanford, Jr., University, Palo Alto, Cal., embodies design and construction features unusual when compared with similar structures recently built. Outstanding among these are: (1) the use of timber in seating structure instead of concrete; (2) the placing of embankment by scrapers to form the support for the seat structure; (3) the speed with which the stadium was built; and (4) the skill and efficiency displayed in the prosecution of the work.

General Description—The stadium consists essentially of an excavated bowl-shaped depression, oval in form, 360 ft. in width and 540 ft. in length at the level of the playing field. The excavated material is placed in an embankment nearly surrounding the depression and the combined slopes of the excavation and the encircling embankment form the support for the seat structure or bleachers. The depth of the excavation is approximately 23 ft. and the height of the embankment 37 ft., both with reference to the elevation of the original ground. A standard four-lap or quarter-mile running track encircles the playing field and extends southward at the east side to form a 220-yd. straight-away.

Grading Methods—Elevating graders drawn by caterpillar tractors were used as the major equipment to excavate the material and load it in dump wagons by which it was hauled and deposited in the fill. Four mules were used with each load, which, on an average, contained 1½ cu.yd., excavation measurement. This method of handling proved most satisfactory both for speed and economy and the resulting progress was noteworthy. With three graders working daily rates of progress as high as 3,696 cu.yd. were reached, and weekly rates of 17,000 to 20,000 cu.yd. were maintained. From five to ten 4-horse fresnos were used constantly to trim slopes and work out corners not accessible to the graders, and a steam shovel was put in for a short time to finish the south end of the straight-away and to excavate the drain ditches. For contract purposes all quantities were measured in excavation.

Embankment—While an allowance of about 8 per cent for shrinkage from cut to fill was made in planning the work, it became evident during progress of the work that this allowance was excessive, and minor revisions were made accordingly in the lines and levels of the pit and the embankment to adjust and maintain a proper balance of quantities. The final result shows very closely a balanced condition, the volume of the excavation at completion being practically equal to the volume of the embankments plus the gravel used for road purposes and stocked for future use. The swell of the material from pit to dump wagon averaged about 30 per cent, and the subsequent compacting of an equal amount in placing it in the fill is evidence of the effectiveness of the packing or tamping action of the mules' feet and tires of the heavily loaded wagons.

PLACING EARTH BERM AS SUPPORT FOR SEATING STRUCTURE—STANFORD STADIUM

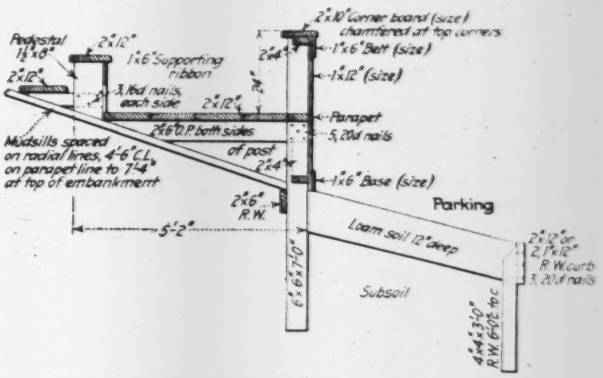
Observations taken during the three months subsequent to the placing of the embankment showed a maximum settlement of less than 1 in., a remarkably small degree of settlement when the fact is considered that approximately 4 in. of rain fell at the site in November and December.

Soil Investigations—As a preliminary to construction operations, pits were sunk to a depth lower than the finished playing-field level to discover the subsoil conditions and water-table elevation. These pits passed through alternating layers of light clays, sandy silts, and coarse sand and gravel. The water table was found to be well below the level of the finished field, thus removing all possibility of trouble from ground water during construction, and simplifying the problem of the

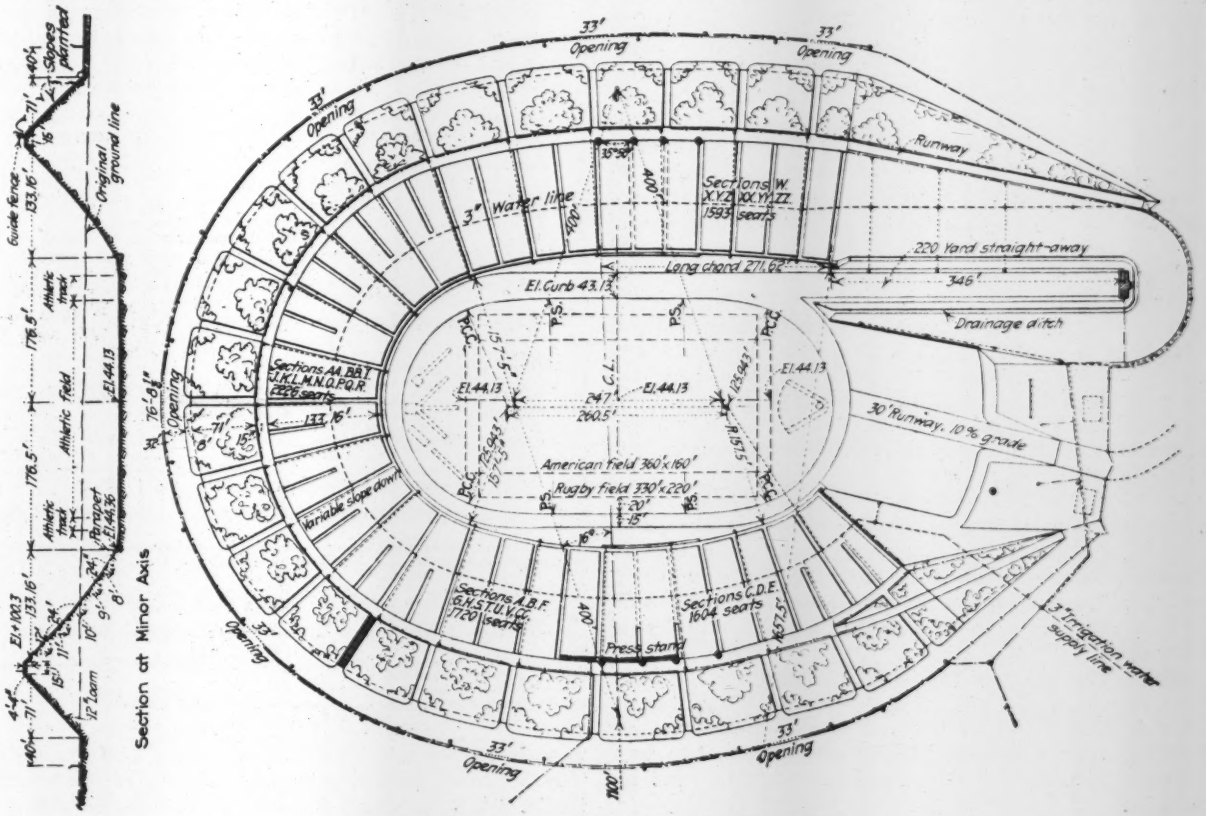
drainage of rainfall and runoff within the bowl. These pits were left open to afford contract bidders an opportunity to inform themselves fully of the nature of the material to be excavated.

Timber Structures—The design of the main timber structure—the bleachers—was developed in a simple form which possesses, nevertheless, the essential requirements of safety, comfort, and economic permanency. More permanent and costly types of construction were fully considered but were rejected as not being required to meet the conditions of use, and as not being justified when investment charges were balanced against maintenance expense.

Inasmuch as the embankment in itself is permanent and non-deteriorating maintenance problems and the annual expense entailed are reduced to the upkeep of a



PLAN, AND SECTION THROUGH SHORT AXIS



CHARACTERISTIC SEATING STRUCTURE DETAILS

very simple seat structure, accessible at all times for inspection and repair.

To illustrate the point of economic permanency, the estimated cost of the bleachers, steps, etc., constructed of concrete was $140,000. The cost of the corresponding structures in timber, as built under the contract was $40,259—a difference of about $100,000 in favor of the timber type. Assuming the life of the timber bleachers, including the redwood mudsills, to be 15 years, and disregarding compound interest, the yearly replacement fund would be about $2,700. Add to this the investment charge at 6 per cent on $40,000, or $2,400, and a total annual charge of $5,100 for replacement and interest is reached. The annual investment charge alone on the cost of the concrete bleachers ($140,000 at 6 per cent) would be $8,400. Without pursuing the comparison further by considering the life or maintenance of the concrete type, nor the fact that a timber seat element is necessary in this type, it is obvious that the timber bleachers are fully warranted on the grounds of economic permanency.

After the bleacher slope of the embankment had been trimmed to very accurate lines, and its gravel surface compacted by a thorough wetting down with hose, 2-in. x 6-in. redwood mudsills were firmly embedded on radial lines spaced from 4 ft. 6 in. at the bottom to 7 ft. 4 in. at the top of the slope. Horizontal checks or headers of 2-ft. x 6-ft. Oregon pine timbers were set in the slope at 12-ft. horizontal intervals on both the inside and outside to prevent erosion or gullying of the slope by rain.

Framing Seating Structure—The pedestals for the bleacher seats and the joists of the footboards were framed and assembled at the mill adjacent to the work

and delivered on the bank in complete units. Similarly, the aisles and steps were framed at the mill and delivered to the job ready to be put in place. Seatboards and foot planks were distributed at convenient points at the top and bottom of the slope and were framed by hand on the pedestals. No. 1 common grade Oregon pine, surfaced four sides, was used throughout the job. The seatboards and the footboards were milled with chamfered or rounded corners to permit interchanging when put in place. Thus a selection of material was possible and the quality of the lumber in the seatboards was correspondingly improved. Curbs for track and roadways were of redwood lumber. Fences of heavy galvanized mesh were installed with redwood posts.

Horticultural Features—The playing field and all slopes of the straight-away and embankment were given a top-soil dressing, which had been stripped previously from the surface of the field. The outside slopes were planted with vetch dotted with selected shrubs and trees which merge the stadium into the natural park-like surrounding landscape. The flat surfaces of the playing field and straight-away are planted with rye-grass turf. With the coming of spring the vetch will probably be replaced by a more permanent type of planting, and the playing field will be seeded with blue grass.

Drainage—While it is realized that a more or less elaborate drainage system will be eventually required for the stadium, no provision for drainage was made in the initial construction. After the run-off and general conditions of drainage have been observed during the first winter season, a permanent system of drains will be designed and installed in conjunction with the installation of the athletic track which was not finished in the initial construction.

Provision has been made for the collecting of drainage water by means of two extensive ditches paralleling and adjacent to the straight-away track and terminating at a sump at the rest house at its southerly end. Pumps of sufficient capacity to handle any waters collected will be incorporated in the drainage plans and installed at a later date.

Cost—The contract for the construction of the stadium was signed May 25, 1921, and work was started June 5, 1921. The contract items were completed on Oct. 31, 1921, on which date a completion notice was issued. The cost of the completed structure was as follows:

Contract items	$163,726.35
Extra work	18,526.48
Gardens and planting	6,387.00
Miscellaneous supplies	5,267.10
Engineering and supervision	16,293.92
Total cost	$210,200.85

The estimated gross receipts from the opening game which was held Nov. 19 when about 60,000 people witnessed the annual University of California - Stanford game, were $213,000, and the net receipts $209,000. The stadium was, therefore, practically paid for at this game.

The design of the stadium was developed by Prof. Charles B. Wing, of the university faculty. The execution of the project was carried out by Baker & Carpenter, San Francisco, as executive engineers for the Board of Athletic Control of Stanford University. The contractors for the construction were Palmer & McBryde, San Francisco, and for the planting, McRorie & McLaren, also of San Francisco.

Analysis of Design Factors for Warehouse Facilities

Unit Values That Insure Adequate Elevator Service, Tailboard Space, Trackage and Shipping Area for Given Floor Space

Abstract of sub-committee report of Committee on Yards and Terminals, American Railway Engineering Association

IN ORDER to insure efficient operation of a warehouse the various service facilities must be properly proportioned to the warehouse floor area. A study of these facilities, or factors of design, i.e. trackage, tailboard space, shipping platform area and elevator service, in fifteen warehouses is presented in Table I.

Elevator Service—Great variation in the amount of warehouse space per elevator may be expected, according to size of warehouse, number of tenants, length of turnover period of goods, and size and speed of elevators.

TABLE I. CHARACTERISTICS OF LARGE WAREHOUSES

No. of Floors.	Floor Space, Square Feet; A Shipping Platform (B)	Storage Space Served by Elevators (C)	Total Storage Space (D)	No. of Freight Elev.	No. of Cars	Tailboard Frontage Lin.-ft.	Remarks
8	44,800	3,894,000	3,894,000	72	93	1,824	U. S. Army (E)
8	37,670	1,344,000	1,573,500	24	90	960	U. S. Army (E)
6	19,800	512,000	565,500	7	28	90	U. S. Army (E)
6	F	600,000	600,000	10	F	101	Over L. C. L. Freight house.
5	20,860	561,100	561,100	15	32	F	Over L. C. L. Freight house.
7	F	357,100	357,100	7	F	F	R. R. warehouse
8	12,110	282,100	282,100	7	20	216	Priv. warehouse
4	22,700	438,300	438,300	6	24	356	Used by one tenant.
8	F	184,400	184,400	6	F	F	R.R. warehouse
6	F	96,600	96,600	4	F	F	R.R. warehouse
8	7,370	201,800	223,900	4	8	100	Priv. warehouse
8	6,840	230,400	256,300	4	9	100	Priv. warehouse
6	50,400	1,261,400	1,421,000	30	100	1000	Priv. warehouse
5	F	145,100	145,100	8	F	633	Over L. C. L. Freight house
4	5,950	185,700	221,600	5	11	100	Used by one tenant.

A—Floor area used is gross area, no deduction having been made in any case for columns, walls, elevators, checkers' booths, scales, aisles, etc.

B—Shipping platform space is the platform space adjacent to car siding used for shipping purposes.

C—Storage space does not include shipping platform space but does include all other space served by elevators.

D—Total storage space includes all warehouse space except shipping platform space.

E—The U. S. Army warehouses Nos. 1 and 2 are located on seaboard, and are served by both boat and rail.

F—Facilities of these warehouses are used by both freight house and warehouse and, therefore, exact amount used by warehouse is not obtainable.

To reduce the many sizes of elevators to a uniform basis they are listed according to their capacity in number of trucks 3 x 6 ft., which seems to be the size in general use in warehouses. The modern tendency is to install larger elevators, the capacity being 1 to 3 trucks in the older and 3 and 4 trucks in the new warehouses, the four trucks requiring a platform area about 9 x 17 ft. Load capacity has also increased with size, from 5,000 lb. in the older to 10,000 and even 12,000 lb. in the newer warehouses.

Increase in speed has been less rapid, since this materially increases the cost. As most warehouses do not exceed eight floors in height, the question of speed is not so vital as in some other classes of buildings. In arriving at a suggested area of warehouse floor space per elevator, it is assumed that elevators will be of a size sufficient for four trucks, with a capacity of 10,000 lb. and a speed of 150 ft. per minute.

Table II shows the actual area of floor space per elevator and the area recommended by warehouse operating officials. The three classifications assist in observing the effect of length of turnover period of

goods. Thus there is a considerable range in values, particularly between the storage warehouses and those where the turnover is moderately rapid. The latter include the railway warehouses in the list. The army warehouses have been designed for a special kind of service, and their elevators are supplemented by derricks, cranes and whip hoists. Two of them have their elevators arranged in batteries with central control,

TABLE II. RELATION OF ELEVATORS TO WAREHOUSE FLOOR AREA

Floor Area Per Elevator Sq.Ft. Present	Recommended by Operating Officials	Number of Tenants	Size of Elevator in Capacity of 3 ft. x 6 ft. Trucks	Floor Area Per Elevator Sq.Ft. Present	Recommended by Operating Officials	Number of Tenants	Size of Elevator in Capacity of 3 ft. x 6 ft. Trucks
Storage Warehouses with Slow Turnover				Warehouses with Moderately Turnover.			
60,000	.....	Many...	3	37,406	.....	Many...	4
50,450	.....	General storage	2	51,014	39,680	Many...	2
57,600	.....	General storage	2	40,300	.....	Many...	3
				73,050	.....	One....	3
U. S. Army Warehouses.				30,733	.....	Many...	3
54,084	.....	One.....	4	24,150	32,220	Many...	1
56,000	.....	One.....	4	42,046	.....	Many...	3
73,143	56,889	One.....	3	37,140	.....	One.....	2

but although this plan increases the effectiveness of the elevators, it is hardly adapted to general warehouse service. We must be governed by the third classification in the table, from which it appears that 40,000 sq.ft. per elevator is a reasonable allowance. This might be increased to 60,000 sq.ft. where the warehouse is used for storage only. Some building ordinances in limiting the space between fire walls automatically limit the floor area per elevator.

Shipping Platforms—In many warehouses the area of platform adjacent to the railroad siding used exclusively for shipping is made larger than required for shipping purposes in order to provide a small amount of storage space. Under certain conditions this is very desirable. For warehouses with moderately rapid turnover the range of values in ratio between platform area and total storage space is 2.7 to 5.2 per cent, with an average of 3.8 per cent. As the lowest figure is for a warehouse with one tenant it is too low for general use. An allowance of 4 per cent would be ample and should give some storage space on the platform; 3.5 per cent might be considered a reasonable minimum.

Railway Trackage—The amount of trackage required depends upon the extent to which the warehouse is supplied by rail, and whether the shipments are from rail to rail, from rail to team or from rail to boat. The greatest amount is needed when shipments are from rail to rail. The length of turnover period of goods is also a factor. In most warehouses, particularly if more than one tenant is involved, it is only possible to make one setting of cars per day. In other cases, with more than one tenant, two or more settings may be possible. In estimating, sufficient trackage should be provided to enable the warehouse to be operated with one car setting per day. In six warehouses the storage space per car length of siding varies from 14,105 to 20,196 sq.ft. An allowance of 17,600 sq.ft. may be considered reasonable.

Tailboard Frontage—The amount of tailboard space required is dependent upon the extent to which teaming is used in handling goods to and from the warehouse. In two storage warehouses where the turnover of goods is slow, the length of tailboard frontage per car-length of siding is 12.5 and 11.1 ft., with storage space of 2,239 and 2,563 sq.ft. per foot of tailboard frontage. In three warehouses where the turnover is moderately rapid, the frontage per car-length is from 10.8 to 19.8 ft., an average of 15.7 ft.; and the storage space per foot of tailboard frontage is from 861 to 1,306 sq.ft. with an average of 1,030 sq.ft. Taking 1,100 sq.ft. as reasonable in connection with the suggested 17,600 sq.ft. of storage space per car-length, it follows that 16 ft. of tailboard space per car-length should be provided.

Summary of Conclusions—Summarizing the suggested relations between the various factors of design we have the following figures which are suggested for warehouses where the turnover of goods is moderately rapid:

1. One elevator for each 40,000 sq.ft. of warehouse space.
2. Shipping platform area should be 4 per cent of warehouse storage floor area.
3. One car-length of track siding for each 17,600 sq.ft. of warehouse storage area.
4. One foot of tailboard frontage for each 1,100 sq.ft. of warehouse storage area.
5. Tailboard frontage of 16 ft. for each car-length of siding.

Filling of Railway Trestles and Steel Viaducts

Points To Be Noted in Making Investigations and Precautions To Be Observed in Conduct of Filling Operations

Abstract of sub-committee report of Committee on Roadway; American Railway Engineering Association

Before deciding to fill a structure, a thorough study of costs must be made, based on local conditions, in order that preference may be given to structures where the greatest saving in future maintenance may be effected. This applies in greater degree to wooden trestles. Long, low structures, where the water can be carried by comparatively small culverts, will show the greatest saving. In steel structures where operating conditions (such as the use of heavier engines) demand replacement by solid fill, and where commercial dirt and ashes are available in large quantities and at the expense of the haul only, other considerations than future maintenance should govern. This preliminary investigation must develop especially the following:

1. Size of culvert, which will generally govern the type of culvert to be used. Emphasis is laid on providing sufficient area to carry off excessive storm water. The character of foundation will govern the design of the culvert.
2. Character of foundation for the new fill, as this may be such that it would not be economical to fill the structure.
3. Condition of the structure. If a trestle is allowed to deteriorate too far, serious difficulties will be encountered in keeping the structure safe for traffic during the progress of filling.
4. Availability and quality of material for making the fill, as both will affect the first cost, and the latter the future maintenance of the fill. Where commercial dirt is available in large quantities, consideration should be given to its character and the cost of the haul involved.
5. Whether the advantage of widening adjacent cuts from which the filling material may be excavated will justify this method of procedure by improved drainage and increased snow room, as against getting all the material from one place.
6. Elimination of fire hazard by filling wooden trestles should be taken into consideration. If there are any springs in the area to be covered, build concrete boxes over them and pipe the water away. Where rock is available and the fall is sufficient, French drains may be substituted for the

pipe. In marsh land it is frequently advantageous to lay a grillage of small tree trunks, old bridge timbers or sawmill slabs.

Preparing the Structure — Before starting, the trestle must be put in shape to stand the stresses incident to filling. This is very important with trestles over 20 ft. high, because if it is not done and the trestle gets out of surface or line (or both), it is almost impossible to get it back into proper shape. Settlement in the surface of the trestle is generally not a serious difficulty, as long as the line is good. Ordinarily, a foundation which is good enough to support a frame trestle will give very little trouble during filling if a bearing 4 ft. wide is provided the full length of each sill.

Special attention should be given to removing all soft timber from bottom of posts, from sills, and from bottom bracing. In a trestle 20 ft. high these parts should be in condition to run two years without repairs, and three years in a trestle 35 ft. high or over, before the structure should be considered in good enough condition to stand filling. It is better to spend a little money preparing a trestle to stand filling than to take a chance of having to spend much more during the progress of the work.

Steel Structures—In steel viaducts, which are usually of greater heights than wooden structures, precautions must be taken to prevent distortion of the column. This can be accomplished by encasing them in reinforced concrete up to a point within 20 ft. of base of rail. Where there is no danger from fire, satisfactory results have been obtained by the erection of intermediate wooden bents at suitable intervals in order to reduce the load upon the towers. As the filling proceeds, all longitudinal and transverse bracing should be cut loose from the bents as the fill reaches the connection points, for this bracing transfers a great deal of load to the bents, which increases the settlement and has a tendency to work the viaduct out of line. Vertical bracing need only be cut loose at the upper connection points.

Methods of Filling — Two methods in general use for filling bridge openings are: (1) By side or center dump cars (or both); (2) by teams from adjacent cuts and borrow pits. Less general methods are: (3) grab buckets swung from cableways; (4) endless belt conveyors; (5) dumping from cars and leveling by sluicing, and (6) by hydraulic excavation and leveling by sluicing.

Where foundation is good, and in low trestles where it is not good, fills can be made by dumping directly from the structure. Good results may be obtained by using a ditching machine, with two 16-yd. air-dump cars for jobs of 5,000 cu. yd. or less, and by steam shovel and air-dump cars for over 5,000 cu. yd. This dividing line is by no means fixed, as it depends on the haul, the depth of cuts from which material is available, and the relative need for ditching the cuts in the vicinity of the structure. The double benefit derived from the use of a ditcher often justifies a greater total expenditure than would be involved in the use of a steam shovel.

For dumping from trestle, the guard timbers should be removed and planks spiked on ties close to the rails to prevent bunching. With center dumping, alternate ties may also be cut out between the stringers. When dumping large rocks, care should be taken not to damage essential members of the structure. It is sometimes advantageous to instill inverted V-shaped wooden shields, with the apex located under the center line of track. This not only affords protection to members which may otherwise be damaged by heavy filling material from a high drop, but it also approximates to the side dump method which results in less disturbance to the structure. The shields must be removed when the filling has progressed so far that the dirt will not fall free of them.

Where foundation is very bad and appears liable to give trouble due to settlement and where traffic is heavy, temporary trestles may be built on each side of the main trestle, from one-third to half the height of the latter, and located so that material dumped from them will spread to cover the area of the completed fill. Belt conveyors or grab buckets may be employed to advantage for fills of this character. Then by dumping simultaneously from all three trestles, or dumping simultaneously from the main trestle and cableways the settlement may be reduced and kept fairly uniform.

Provision for Settlement—It is often advisable to make a long haul to obtain a better grade of material in order to stabilize the fill and reduce cost of future maintenance. Sufficient material should be deposited to allow for shrinkage of embankment and subsidence of foundation. Fills subject to erosion by rivers may be made more compact and repellent to water action by having the dirt spread by teams in layers over the entire area to be covered.

When filling trestles of over approximately 25 ft., it is good practice to install a small pump, if there is water available at the opening, and run a pipe line underneath the ties through the center of the trestle, having valves at intervals so that the trough formed by dumping on both sides of the trestle (or the central core when center dump cars are used) is kept continually wet. In this way settlement occurs gradually as the filling is deposited, with the result that the filled trestle is not carried so badly out of line and surface. This also gives a solid puddle core to carry the weight of trains.

Immediately after the filling of low trestles, the stringers should be removed, but in high trestles they should not be removed until the fill has settled as far as it will without the load of trains. If a high trestle has become so badly out of line and surface that it cannot be resurfaced and relined, it is better to remove the stringers at once and put the load on the green fill, even if this requires considerable watching and resurfacing of track for some time.

Care should be taken to avoid the formation of a trough which will hold water when removing stringers. This may be done by filling the openings left by stringers with a good grade of clay, and tamping and crowning before applying ballast. On account of cheapness and ease of handling, track should be ballasted on engine ashes until new fill has stopped settling. Where engine ashes or commercial dirt is used for making a fill, great care should be taken that the fill does not catch fire. On a large job of this kind it is always well to have a good sized pump with sufficient fire hose to overcome fire, which may start when least expected.

Hydraulic Filling—In this process, used in hillly country, water from a convenient mountain stream is diverted to supply hydraulic jets or "giants" which excavate material, the water then carrying the material through box flumes to the site. To form the fill, low levees or dikes are built along the lines of the side slope to form a pool in which the material settles while the water drains away. These levees are usually constructed of alternate layers of earth and straw or hay. Tough marsh grass is best suited for this purpose. The material is spaded from the inside and the hay is distributed by a man walking along the dike. The next layer of earth compacts the hay and is quickly puddled by the action of the water. The embankment is constructed usually to within 3 or 4 ft. of its finished elevation, and is then completed by train.

Banks constructed in this manner are remarkably solid. Further, the hay or straw has the advantage of protecting the newly made bank not only during the first year but subsequently, as the seeds germinate and form a sod.

Thames Water Supply Draft and Storage

The amount of water which the Metropolitan Water Board, London, England, is permitted to take from the River Thames is 130 Imp.m.g.d. except at times when the flow of water over the Paddington weir exceeds 200 Imp.m.g.d. Storage reservoir capacity now provided, according to a recent lecture before the Royal Institute of British Architects by H. E. Stilgoe, chief engineer, Metropolitan Water Board, totals 6,600 Imp.m.g. which will be nearly doubled on the completion of the 6,500 Imp.m.g. Littleton reservoir now under construction.

Delaware Practice in Road Structures

By Carlton V. Conner

Formerly Designing Engineer, State Highway Department of Delaware

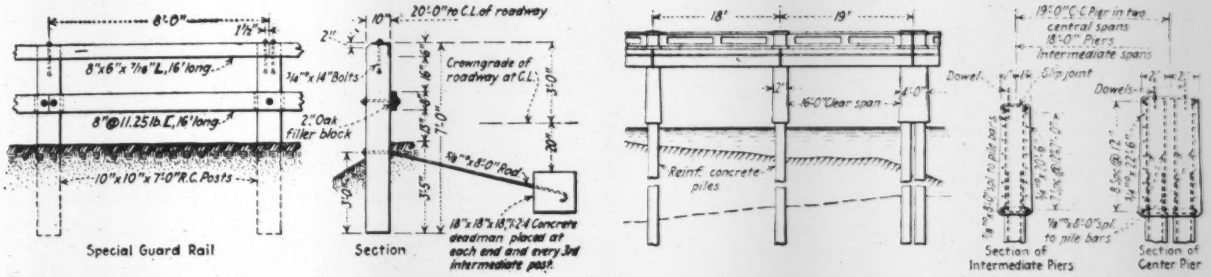
HIGHWAY standards in Delaware require a minimum width of clear roadway at all structures of 32 ft. and a minimum depth of earth fill between the bottom of concrete roadway and the top of slab or arch ring of 6 in. Structures are all designed to carry the concentrations from a 20-ton truck, in addition to the dead-load. The accompanying photographs show the standard types of bridge construction in crossing tidal marshes.

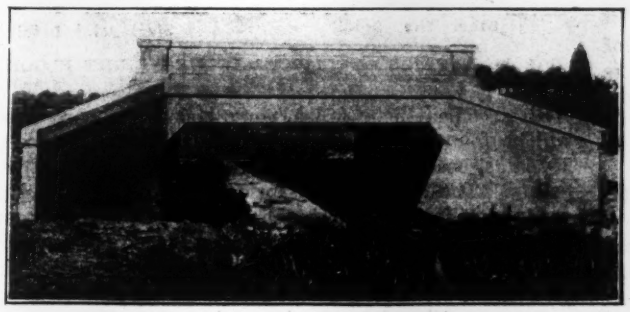
A reinforced-concrete-pile trestle has shown considerable economy over other types of permanent construction, especially in places where mud is encountered to depths of 50 or 60 ft.

A guardrail made up of reinforced concrete posts with concrete "dead-men" and rail of structural steel sections, was designed to be placed along the Philadelphia Pike. On account of the heavy traffic and the fact that this construction is in a residential district, it was necessary to combine strength and suitable appearance.

Grading Costs on Federal Aid Roads

A GREAT variation in the conditions under which grading for highways is done in different sections of the United States is reflected in cost data compiled by the Bureau of Public Roads on 1,350 projects of federal-aid road. The figures cover the four-year period 1917-21 and are based on a total of 24,526,415 cu.yd. of earth. For the groups of states the average price per cubic yard is as follows: New England and Middle Atlantic States, $1.33; East North Central, $0.68; West North Central, $0.49; South Atlantic, $0.61; East South Central, $0.41; West South Central, $0.35; Mountain, $0.52, and Pacific States, $0.61. The general average price was $0.56. Probably the most important factor affecting the cost was the amount of grading to be done per mile, the quantity being very small in the groups having the highest prices. In general it is noticed that where mostly old roads are rebuilt the light work and tearing up the old pavement greatly affected the cost. The amount of fine grading or trimming required for the higher types of pavement was also a factor. Labor, character of soil, climate, contract time limits and detour expense affected the cost.





STANDARD BRIDGE TYPES AND DETAILS OF PILE TRESTLE AND OF GUARD RAIL, DELAWARE

Design and Construction of Light-Weight Floor Systems

Practical Details of Long Spans for Light Loads, Comprising Core Construction, Steel Joist and Precast Slab Types With Special Attention to the Core System

By Jacob Fruchtbaum
Buffalo, N. Y.

During the last few years, the greater portion of construction projects consisted of school buildings, hospitals, churches, apartment houses and hotels, in general fireproof buildings, whose floors carry light loads on long spans, and whose design, therefore, is governed by bending moment and not by shear. Since the lower portion of the slab serves little or no purpose in taking compression, it becomes desirable to eliminate most of the concrete below the top two or three inches, leaving just enough of joist below that plane to take care of the shear requirements and convenience in the placing of the steel. This type of construction is generally known as the "hollow floor," "core system" or "ribbed slab" construction.

Structurally, these slabs consist of joists 4 to 6 in. wide, spaced from 16 to 36 in. on centers, with a 2- to 3-in. slab forming the flange of the small T-beams. Any desirable depth of floor can be obtained by varying the depth of the material used to form the joist; the ordinary depth, however, ranges from 4 to 14 in.

Another type of floor used for this class of buildings consists of steel joists spaced from 12 to 24 in. on center and having metal lath fastened to the top and bottom of the joists. On the top lath a 2-in. layer of concrete is placed. The bottom lath is used for plastering, but is omitted where no ceilings are required.

Structural steel may be used in the same manner as steel joists, and as reinforcing steel in the ordinary core type of construction.

Still a third type of light-weight floor consists of precast slabs of either gypsum or concrete. These are sold under a variety of trade marks in both flat and ribbed forms.

Core Construction

Advantages—Core construction is not a cure-all. Its very nature makes it uneconomical for heavy loads or short spans, especially in wall bearing jobs, where dead-load is of minor importance; neither are all types equally economical under all conditions. Thus, we may expect that the shorter the span and the heavier the load, the more suitable will terra cotta with a 16-in. c. to c. spacing prove in comparison with steel-tile construction with a 24-in. spacing (since the ratio of shear to compression is greater). Because of its adaptability for long-span work, core construction renders possible elimination of intermediate beams, thus either giving more head room or reducing the story height. Due to the saving of brick, tile, and expensive stone facing, the latter will generally be of some account in multiple-story buildings. The most important item is, however, the saving in concrete not only in the floor slabs themselves, but, due to the reduced dead-load, in the supporting beams, columns and footings as well. In addition, there will be a considerable saving in material handling charges and formwork. The equipment charges will be the same as for a beam-and-girder job having the same floor area and story height.

With flat ceilings the number of nozzle heads required for a sprinkler system will generally be 20 to 30 per cent lower than for a beam-and-girder floor. This, in addition to the saving in the size of the feeder pipes, will offer a net saving of 10 to 20 per cent of the entire installation.

A better distribution of light, and a greater utilization of daylight is another by-product of the flat ceiling of core construction.

Because of the air space, core construction offers a floor that is more or less effective in deadening sound and preventing condensation. Where a wood floor finish is used, this sound deadening is considerably improved.

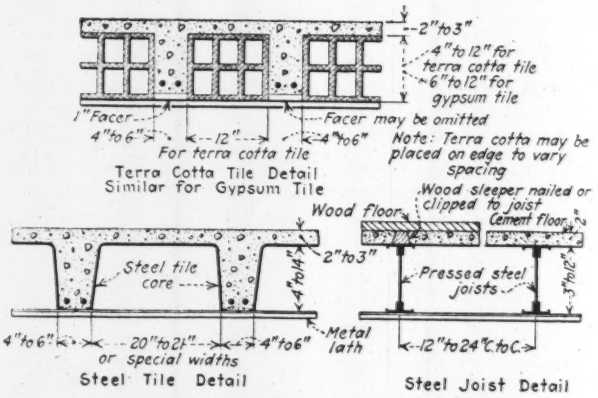


FIG. 1. DETAILS OF TYPICAL LIGHT-WEIGHT FLOORS

With a cement floor finish, some sounding board effect will be found at the joists, as well as at the flanges of T-beams, because of the solid mass of concrete at those points. The best remedy for the above is to use suspended ceilings, since in that case a continuous air space is provided. In addition, suspended ceilings allow replacement and inspection of floor piping at a minimum cost.

Gypsum tile slabs having joist facers possess an additional advantage in that only two-coat plaster work is required. Two-way core slabs were at one time very popular. If properly designed, they are seldom economical, although they reduce the depth of the floor construction. They should not be used except for practically square panels.

Method of Design—Core slabs are designed in the same manner as ordinary T-beams. For purpose of illustration, let us assume the following data:

Span.—Simp'e o, 20 ft. c. to c., 19 ft. in clear
Live-load = 75 lb. per sq.ft.
Wood floor finish = 18 lb. per sq.ft.
Fireproofing = ½ in.
f_s = 16,000 lb. per sq.in.
f_c = 650 lb. per sq.in.
n = 15

Using steel tile for core fillers, then, the design is as shown in the table at the top of page 731.

Design		Loads
10 + 2*.	$w = 156 \times 2.17 = 338$ lb. per lin. ft. of joists	10 + 2 = 56**
5-in. joists	B.M. $= \frac{338 \times 20^2}{8} = 16{,}900$ ft.-lb. $= 203{,}000$ in.-lb.	L.-L. = 75
26 in. c. to c.	Stress $= \frac{203{,}000}{(10.75 - 1)} = 203{,}000$ in.-lb.	Finish = 18
1 1-in. round straight 1 ⅞-in. round bent	$A_s = \frac{20{,}800}{16{,}000} = 1.30$ sq.in.	Ceiling = 7 156 lb. per sq.ft.

*10 + 2 indicates a 10-in. core with a minimum concrete topping of 2 in. giving a total slab thickness of 12 in.
**The dead-load will depend upon the type of core used and width of joists. It may be obtained in each case from tables furnished by the manufacturer who supplies the core material.

One 1-in. round and one ⅞-in. round furnish 1.39 sq.in. and will be used.

Neglecting compression in stem, and assuming value of kd to remain fixed, the average safe compression per square inch of flange is $\frac{650(3.08)}{4.08} = 491$ lb., since $kd = 0.379(10.75) = 4.08$.

Safe compression on slab $= 491(26)(2) = 25{,}500$, that is, the slab is safe in compression.

In this particular problem, many designers would use two ⅞-in. rounds in every other joist, and one 1-in. round and one ⅞-in. round in the alternate joists, thus giving an average area of 1.30 sq.in. Unless transverse reinforcement is furnished, this is not considered good practice, especially with a wide spacing of joists, or where the difference in steel between adjacent joists is large. This practice also slows up the field work in connection with the placing of stee'

With reference to shear:

$$V = \frac{338 \times 19}{2} = 3{,}210 \text{ lb.}$$

$$v = \frac{3{,}210}{5 \times \frac{7}{8} \times 10.75} = 68 \text{ lb. per sq.in.}$$

where V = total end shear.
and v = maximum unit end shear in lb. per sq.in.

Except for long spans, or where anchorage or continuity steel is needed in the top, no bent bars are required where the shear is less than 40 lb. per square inch. With properly anchored bent bars, such as bars with hooked ends, or those carried a sufficient length past the neutral axis to develop their full strength in

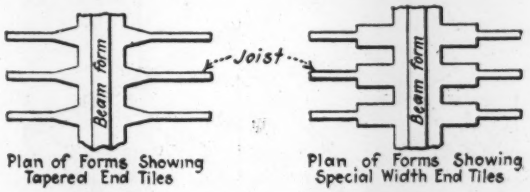


FIG. 2. METHOD FOR INCREASING CONCRETE JOIST AT SUPPORTS

tension (40 to 50 diameters), a shear of 60 lb. per square inch may be allowed on the section. Where the shear is greater than can be taken care of by the bent bar and the concrete in the joist, either tapered ends, or a narrower width of tile may be used at the support to increase the concrete joist area. (See Fig. 2.) It is very expensive to place numerous small stirrups, and, rather than resort to them, it will prove more economical to deepen the slab. In simple spans, the bars may be bent so as to take the excess shear. In continuous spans, if the bars are to be of any value in taking tension due to negative movement they must be bent down too far away from the support to be of use in withstanding shear.

To illustrate the methods of figuring compression at the support, assume that the slab in the previous problem is continuous; then

B.M. $= \frac{2}{3}(203{,}000) = 135{,}200$ in.-lb.

$$C = T = \frac{135{,}200}{\frac{7}{8} \times 10.75} = 14{,}370 \text{ lb. (at support).}$$

Safe compression on stem $= 0.413 \times 10.75 \times 5 \times 375 = 8{,}320$ lb.

Stem can take all the compression at a distance*

$$1.05 \times \frac{(14{,}370 - 8{,}320)}{69 \times 5} = 18 \text{ in. from center line of support.}$$

*Negative moment at a distance x from the support $= \frac{wl^2}{12} + \frac{wx^2}{2} - \frac{wlx}{2}$.

That is, the decrease in moment is $\frac{wlx}{2} - \frac{wx^2}{2}$ or decrease in compression,

$$D = \frac{\left(\frac{wlx}{2} - \frac{wx^2}{2}\right)}{jd}$$

Neglecting the second term in the parenthesis, $D = \frac{Vx}{jd} = bvx$ or $x = \frac{D}{bv}$

The omission of the second term will seldom cause an error over 5 per cent so that $x = 1.05\ D/bv$.
The same principle offers a simple method for locating points where compression or tension steel may be stopped.

If the supporting beam has a wide enough flange, no special ends are required, otherwise, a narrow or tapered end tile can be used. Compression steel is figured in the ordinary manner, except that with wide beam flanges it is not always necessary to lap the bars. Thus, with a 15-in. imbedment in flange, and an allowable bond stress of 100 lb., a 1-in. square bar will carry by bond $15 \times 100 \times 4 = 6{,}000$ lb. (This value must not, of course, exceed the allowable stress in compression.)

Width of joist required at center line of support $=$

$$5 \times \frac{14{,}370}{8{,}320} = 8.6 \text{ in.}$$

Bond stress is a negligible item since the shear is low and bent bars are generally provided, leaving very little shear to be taken by the concrete.

Terra cotta and gypsum tile slabs are designed in the same manner.

Methods of Detailing—The general principles of detailing reinforced concrete apply with equal force to core construction. Some special points will, however, be taken up. In continuous slabs considerable difficulty is experienced in taking care of the compression at the support. Where the slab is supported by concrete beams, the tile is kept back far enough to provide the beam with sufficient compression flange; and, due to the rapid decrease in the negative bending moment, the concrete stress in the joists will generally be satisfac-

tory. But where the slab is supported on structural steel beams or walls, or if the concrete stress at the edge of the beam flange is too high, either a tapered end tile or a narrower width tile may be used at the end of the row. Where these methods are unsatisfactory or insufficient, compression steel is introduced. In many instances it will be more economical to use a deeper tile and a lower stress than that allowed, and thus avoid compression steel, or a large mass of concrete. The methods of taking care of excess shear have been discussed under the subject of design.

Where partitions and concentrations occur, the concrete is generally overstressed. In some designs double joists are used to overcome the difficulty; and while this method may be satisfactory for short spans, or for a close spacing of joists, it will not do for the average case. Assume, for example, that 4-in. joists are spaced

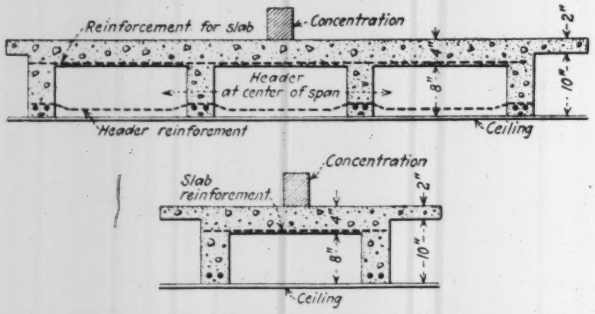


FIG. 3. METHODS OF SUPPORTING CONCENTRATED LOADS

24 in. on center. Doubling the joist width will give an 8-in. joist 28 in. on center. While the load is approximately doubled, the width of the compression flange has only been increased from 24 to 28 in., that is, less than 17 per cent. The best method is to use a shallower tile, that is, if the slab is 10 + 2, use an 8 + 4 for as big a width as is required to develop the compression, and distribute the load over the several joists by reinforcement in the topping or headers. As a final resort compression steel is added. (See Fig. 3.)

Where terra cotta tile or gypsum blocks are used, it is advisable to use a joist facer between the various blocks, so that the entire plastering will be done on a uniform surface. The joist facer serves an additional purpose in securing an even width of joist, but is difficult to place. Where suspended ceilings occur, the facers are omitted.

To obtain the required length of the rows of tile; with steel tile, vary the lap; with gypsum, saw the end blocks, with terra cotta, the length to the nearest 6 in. only can be used.

Where small openings occur in the floor, it is advisable to stop the rows of tile on both sides of the opening and close them with end caps, thus securing a piece of solid slab in which to form the opening. With large openings, or those occurring at joists, headers should be used.

On account of their large bulk, weight, and breakage, terra cotta and gypsum blocks will generally prove expensive, unless the plant where they are made is near by. Gypsum should be waterproofed and stored carefully before being used.

Shrinkage steel (¼ in. round at 12 in. or 18 in. c. to c.) should be used in all slabs, especially those with thin

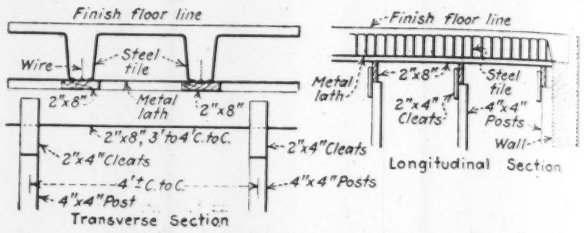


FIG. 4. DETAILS OF FORMWORK

floor finishes or no dead air space on the underside.

Formwork.—The joists are formed by either removable forms of steel or wood, or left-in-place forms of steel, terra cotta or gypsum. Where ceilings are lathed and plastered directly on the underside of the floor slab, left-in-place forms should always be used as, due to difficulties in fastening the metal lath rigidly enough to offer a firm base for plastering, methods utilizing removable forms have proved failures. However, even where suspended ceilings are used or no plastering is done at all, it is seldom advisable to use removable forms due to their large initial cost, rapid depreciation, and expensive storing and moving. In general, even the lightest of removable tiles must be used at least three or four times to prove economical.

Suspended ceilings produce a more sound-proof floor, but are seldom used because of their greater cost and encroachment on head-room. However, many plasterers prefer to work on a suspended ceiling than on metal lath that is directly fastened to the underside of the joist, due to a policy, that is fortunately disappearing, of some contractors not wiring the lath into the concrete joists. Where the plastering is done a long time after the lath is placed and there is any danger of rusting, copper bearing or pure iron lath is often used.

The forms treated thus far dealt with forming the joists. The matter following refers to the material supporting the steel, terra cotta, or gypsum tile, during the process of construction.

With steel and gypsum tile, forms are required under the joists only, and in view of the width of the joists, the 2 by 8 plank has become practically standard for

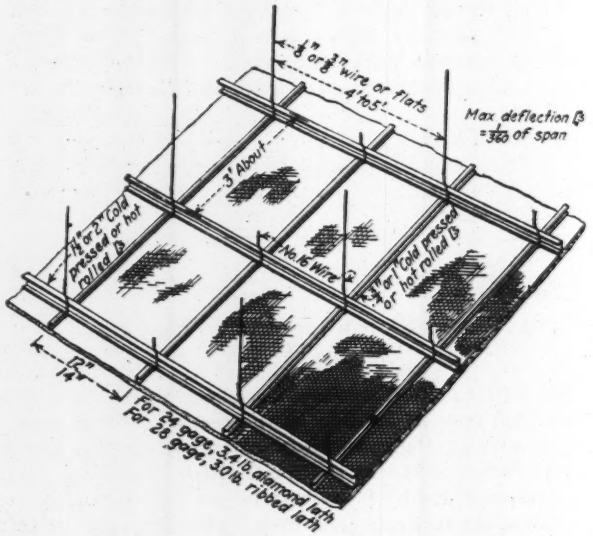

No. 8 or 3/16" wire or flats
4' to 5'
Max deflection = 1/360 of span
3' About
No. 16 Wire
12"
14"
For 24 gage, 3.4 lb. diamond lath
For 28 gage, 3.0 lb. ribbed lath

FIG. 5. SUSPENDED CEILING DETAILS

the underside of the joists. To avoid additional sizes, it seems most economical to use the 2 x 8-in. for stringers as well.

Two types of forms are used. In both types a 2 x 8-in. plank is placed under the concrete joist, but while in one type a 2 x 8-in. is run on edge under the horizontal plank forming a continuous T, in the other method the vertical planks are placed on 3 to 4-ft. centers under the horizontal planks and at right angles to them. It is hard to say why the first method survives, as it is considerably more expensive in both material and labor. Some contractors form the floor solid; however, this is an absolute waste, and except for terra cotta tile, should not be used.

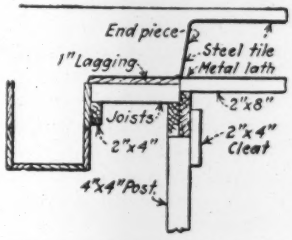


FIG. 6. FORM DETAIL FOR BEAM FLANGES

The load carried by the horizontal plank will be determined by the deflection allowance. Assuming partial continuity, and

w = uniform load in lb. per ft.
l = span in ft.
E = 1,200,000 lb. per sq.in.
I = 3,461 in.⁴ for 2 x 8 in. horizontal plank (1⅝ x 7⅝ in. dressed)
I = 67.88 in.⁴ for a 2 x 8 in. plank placed on edge.
wl^3 = 10,250 where deflection is limited to 1/360 of the span; and, wl^4 = 38,500 where deflection is limited to ¼ in.

Thus, a 2 x 8-in. horizontal plank will carry 475 lb. per running foot on a 36-in. span, 256 lb. on a 42-in. span and 150 lb. on a 48-in. span where deflection is limited to ¼ in. and 380 lb. per running foot on a 36-in. span, 240 lb. on a 42-in. span and 160 lb. on a 48-in. span, where deflection is limited to 1/360 of the span.

With a maximum fiber stress in tension or compression of 1,200 lb. per sq.in., and a maximum stress of 200 lb. per sq.in. in shear, we get for a 2 x 8-in. on edge

wl = 5,425 for shear requirements, and
wl^3 = 17,520 for moment requirements (partial continuity assumed)

That is, for spans up to 3 ft. 3 in. shear governs the load, while above that, moment governs. Deflection will not be a deciding factor. Therefore, the safe joist load per running foot is 1,095 lb. on a 4-ft. span, 701 lb. on a 5-ft. span and 487 lb. on a 6-ft. span. Posts and bracing are figured in the ordinary manner.

With terra cotta tile construction, it is advisable to form the entire floor. In view of the close spacing of joists, there is no economy involved in using 2 x 8-in. at 16 and 17 in. on center over using 1-in. roofers solid. The only additional lumber is the slight number of battens required. Besides, a solid floor will make the work slightly more economical than would otherwise be the case.

Construction.—Where several lengths or sizes of material are used to form the core, it has been found more economical to place all material of one size, then of the other, and then of the third. Thus, for example, in a steel tile job, the most economical arrangement of the work would be to place the metal lath first, wire it, place the pieces of one size of tile, then of the other, and finally the end caps. Considerable time is saved and economy obtained in arranging the work as indicated above rather than making up each row separately. The same general principles hold true for terra cotta or gypsum slabs.

The ribs of the metal lath in steel tile construction should be wired into the concrete. The additional cost of this labor is more than offset by the saving in plastering cost. It is advisable to nail the tile down to the forms every 8 or 12 in. to prevent the tile from bulging. Especially is this true of the lighter type of steel tile, where over-runs in concrete as much as 15 per cent may result because of the deformation of the steel tile. With the terra cotta and gypsum tile it is also advisable to wire the spacers into the joists or provide some mechanical arrangement for holding them in place.

In all types of core construction it is very essential that no trucking be done on the cores but that plank runways be provided for that purpose.

Where the concrete topping is to be troweled smooth without putting on any extra finish, special precautions must be taken with steel tile that has a crown, as there is a tendency for the tile to deform due to the floating of the finish. A flat tile stands up better under that action. However, it is advisable, in most cases, to use a ¾-in. cement finish and not try to float the top.

Steel Joists

Advantages—Where dead weight is an important item, as in tall skeleton frame buildings, especially with heavy foundation work, we may expect steel joist construction to prove economical. It furnishes the lightest weight floor made, and, consequently, offers the biggest saving in the supporting beams, columns and footings.

Flat ceilings are obtained with this type of construction, offering advantages similar to those previously discussed under core construction.

Another advantage of steel joist construction is found in the fact that the concrete is not figured to take any structural stress. During cold weather it is thus possible to pour the roof first and do the rest of the work under cover.

Methods of Design and Detailing—There has been considerable discussion lately about the possibility of designing steel joist to compete, in initial cost, with wood construction. Some very radical statements have been made with reference to the above. However, it seems very questionable whether steel joint construction will, in the immediate future, be able to do that, especially so, as wood joists are generally designed for comparatively high stresses. If steel joist construction is to be more economical, it is certain that the deeper

TABLE SHOWING DESIGN OF STEEL JOISTS

10 in. — 8.8 lb. joists
23½ in. c. to c.
2 in. topping

$w = 114\ (1.96) = 224$ lb. per ft.

$\text{B.M.} = \frac{224 \times 20^2}{8} = 11{,}200$ ft. lb.

$S = \frac{I}{e} = \frac{11{,}200 \times 12}{16{,}000} = 8.4$ in.³

10 in. — 8.8 lb. I provides 8.4 in.³ and will be used; or we can use a 10 in. — 9.5 lb. joist with a section modulus 7.6 in.³ spaced at $\frac{23.5\ (7.6)}{8.3} = 21\frac{1}{2}$ in. c. to c.

Load

Finish	= 3 lb.
2 in. slab	= 24
Joists	= 4
Ceiling	= 8
L. L.	= 75
	114 lb.

joists will all be composed of built-up sections, thus strengthening the members in moment and weakening them in shear and consequently producing a better balanced member for the use to which it is put.

Where special loads, such as partitions, occur the spacing of the joists can be decreased or another joist added to make up for the additional section modulus required.

The economical joist to use is that one which will give the least weight of steel per square foot of floor area. A ribbed lath should be used on both top and bottom of the joists to give the desired rigidity. To obtain a satisfactory job, a 24 gage ⅜-in. ribbed lath weighing at least 4.8 lb. should be used on top while on the bottom, for any spacing over 18 in. on center, a 26 gage ⅜-in. ribbed lath weighing at least 3.6 lb. per square yard should be used. For shorter spans, a 28 gage ⅜-in. ribbed lath weighing at least 3 lb. per square yard may be used. This last item, of course, will have to be considered in deciding upon the economical spacing of joists. As a general rule, however, it will prove most economical to use a spacing as near 23½ in. as possible and thus take full advantage of the strength of the lath.

It will be noted that special attention is paid to weight and depth of rib instead of effective cross-sectional area. This is due to the fact that where the material acts as a form, the important item is the depth of the rib and its weight. Its effective cross-sectional area comes into play only after the concrete has set and has begun to act as reinforcement. This is a very important point often overlooked by the people who should know more about it. The weights and types of lath used are standard with nearly all manufacturers.

The use of ribbed lath is practically admitted as a necessity by all engineers. If the rib is to be of value, every rib should be fastened to the steel joist.

The web of the joists and the spacing of spot welds along the flange should be tested for shear in the same manner as they are for built-up structural steel girders, and, for short spans, they may be the governing factors. Some designers use bridging to stiffen the members. As it is absolutely useless in compression and practically useless in tension, its only justification is in its aid to the erector. Some contractors put on the bridging after the floor is all placed with the idea of carrying out the intention of the drawings. It is evident that the bridging in that case has not been used even to fulfill the pretense of its being an aid in construction. Ordinary wire or wood spacing strips will answer the purpose for erection, and, for stiffening after the concrete has set, ribbed lath should be used.

Where the joists rest on walls, anchors should be provided and the joists punched to receive them. Where they rest on structural steel beams or angles, some provision should be made for clipping or bolting them to the supporting members, and sufficient bearing should be provided. Where they frame into structural steel members so that the top joist is at the same level as the top supporting member, coping is resorted to. Where steel joists frame into concrete beams, some continuity is occasionally figured; it is not, however, considered good practice to do so whether anchors are provided or not.

Shrinkage rods (¼ in. rounds 18 in. c. to c.) should be used with all steel joist slabs. The rods are to be placed at right angles to the ribs of the metal lath.

Formwork.—No formwork whatsoever is required with steel joist construction, as the concrete is poured directly on the metal lath. The only precaution is to use a comparatively dry mix of concrete. The elimination of forms is a very important item in buildings that have large story heights such as occur in auditoriums, gymnasiums or other public gathering halls.

It is not economical to use a metal lath that will deflect considerably and thus increase the concrete quantities. Neither is it good policy to use a metal lath with too big a mesh so that the neat cement will run through. It is believed that the recommendations made under methods of design and detailing will prove satisfactory.

Construction—The most economical way to proceed with the work is to lift the joists and place them on their supporting members in bundles and then spread them out to their locations as indicated by marks previously made on the supporting members. Some kind of bracing or wooden strips should be used to keep them in their proper location. Metal lath for the top is placed next (allowing the proper laps), ends wired and then clipped to the joists. A comparatively dry mix of concrete can then be poured. The lath for the underside is applied after the concrete has been poured. It also is clipped to the joists in the same manner. The most economical way of applying the clips will depend upon the type of clip used.

If a wood finish is to be used, wooden strips are placed and nailed down or clipped down before any concrete is poured. No trucking of any kind should be allowed on the metal lath.

Structural Steel—Where structural steel members are used as steel joists, the floors are designed and built in the same manner as indicated under steel joist construction. Where used as reinforcing steel, they are also used to support the forms for the slabs during construction, so that all or nearly all posts and bracing are eliminated. When used as reinforcing steel, they are figured in the same manner as ordinary core slabs, except that shear along the top flange, and steel stress in the extreme fiber should be carefully checked. As a matter of fact, it is a very difficult matter to really figure stresses in this type of floor because of meager analyses and tests at present available.

The use of structural steel has several advantages in that it eliminates most danger due to removing the forms too soon and makes possible the use of a suspended ceiling, giving a continuous air space, at no additional cost. Against that must be offset the uneconomical present methods of figuring it, the greater depth of floor construction that it requires and difficulty in obtaining continuity where desired. With reference to the first objection, it must be admitted that all tests show that the present methods, if sanely applied, are on the side of safety, considerably in excess of the average requirements.

Precast Slabs—The only practical use for these is in roofs and then primarily in industrial buildings. Their great advantage is their light weight, economy in handling, elimination of form work and independence of weather. They are generally reinforced and designed to span four to five feet. To obtain an economical design, the purlins must be so spaced that the minimum number of

special sections will be required. Where ventilators or openings occur in the roof, special sections cannot be avoided. The great difficulty with this type of construction is the fastening of the material to the structural steel supporting members, and, in localities subject to severe winds, it is not unusual to hear of these roofs being seriously disturbed, especially where no openings are provided to relieve the pressure inside of the building. These slabs are cast in durable molds as the amount of duplication is very large. The concrete slabs may be cast by either a wet or dry mix process, the wet mix producing a denser concrete.

Compensation of Engineers in the Employ of Philadelphia

Number of Men Under Various Salaries and Classes Compared with Recommendations of Engineering Council's Committee

By James W. Follin
Staff Engineer, Bureau of Municipal Research of Philadelphia

As a byproduct of a study made by the Civil Service Commission of Philadelphia of the classification of positions in the municipal service, there is certain information available on the compensation of engineers which may be of interest to engineers generally. The information was derived from class sheets used by the classification consultants (Griffenhagen & Associates, Ltd., in a report made in 1920), and which were made available by the Civil Service Commission. A class sheet was prepared for each grade of employment in the proposed classification of the engineering service, and the existing positions with their salaries were listed on these sheets according to the judgment of the classification consultants, with the advice of administrative officials. A compilation of the information obtained from these sheets gives the salary distribution of the entire 319 positions classified under the engineering service, according to the several vocational groups. It makes it possible to determine the percentage of positions which carry compensation within certain ranges, such as, for instance, the salary ranges suggested in connection with its plan for classification of engineering positions by Engineering Council's Committee on Classification and Compensation of Engineers. (See *Engineering News-Record*, Jan. 15, 1920, p. 117.)

Engineering Pay Inadequate—Table I shows us that out of a group of 319 engineers in municipal service in Philadelphia, approximately 50 per cent were receiving in 1920 (no general increases have been made since then, and in 1922 a reduction in the bonus has reduced some compensations) salaries ranging from $1,620 to about $2,700 a year, the range of salaries suggested by Engineering Council's committee for the position of junior assistant engineer. For entrance to this grade no experience was specified by the committee if the applicant possessed a professional degree, and promotion to the next grade of assistant engineer with salaries from $2,700 to $4,140 was made possible after only two years' experience in the junior grade. Only 18 per cent of the entire group of 319 engineers in Philadelphia were receiving in 1920 salaries above $2,700, while 32 per cent were paid less than $1,620.

While it has been recognized that municipalities generally are parsimonious in their payment for technical services, specific information to support this recognized fact has been very scarce. Information on the entire engineering personnel of a large city may be useful to engineering societies. In this connection it should be added that the large number of inspectors which are connected with engineering work (such as highway inspectors, sewer inspectors, etc.), are not included under the engineering service, but under the skilled and semi-skilled trade service, so that the comparatively low salaries paid such employees has not operated to reduce the average compensation of the engineering service.

There may be some disposition to discountenance the use of the salary rates set up by Engineering Council in a time of high prices as a basis for comparing the adequacy of existing salaries, but few would disagree that the information set forth in Table I shows quite clearly that the rates of compensation in the engineering service in Philadelphia are grossly inadequate, and are not conducive either to attracting a high grade of engineer to the municipal service or to holding him there after he has become adjusted to his duties and is of maximum usefulness to the city. The present scarcity of engineering positions on the outside, with the resultant increased demand for municipal positions, is unfortunate for our municipal engineering services because it is most difficult to secure increases from legislators when the positions are being eagerly sought after. However, increased activity on the outside will

TABLE I—COMPENSATION FOR ENGINEERING SERVICES, CITY OF PHILADELPHIA, PA.

Number of positions at the various rates of pay which were classified under the several vocational groups of the engineering services in the studies on classification of positions made by Griffenhagen and Associates, Ltd., for the Philadelphia Civil Service Commissions in 1920

| Vocational Groups | Suggested Salary Range | | Salaries Including Bonus, Dollars per Year | | |

probably result in an exodus of engineers from municipal service with a consequent loss in working efficiency to the municipal organizations. It is unfortunate, with such a good field to choose from, that salaries are not now more nearly adequate so that the qualifications for the positions at present vacant could be raised to the limit and the very best men secured.

It will probably not be very encouraging to the engineer who quite often has accomplishments to his credit somewhat in excess of the average non-professional man (although this point is frequently over-emphasized), or to the teacher of engineering who is directing the careers of the coming generation, to learn that in one of the large groups of engineers in municipal service one out of every two is receiving between $1,620 and $2,700 a year, the equivalent pay of the worker in the skilled trades or of the ordinary salesman. And numbered among the incumbents of such low-paid engineering positions are men with professional degrees and as high as ten years of experience.

Engineering Pay Lags Behind—It is a well-known fact that the increases in pay for engineering and scientific services lagged behind the pay increases of many other groups during the time that the compensation curve was on the up grade to offset the rapidly increasing cost of living. Figures show that the engineer in municipal service in Philadelphia was much worse off than the average city employee—whose condition was bad enough. The purchasing power of the average engineer's salary in November, 1920, was only 62 per cent of the purchasing power of December, 1914, while in December of 1921 the drop in prices had only raised this value to 75 per cent. The average city employee, on the other hand, was some ten points higher in the scale. These facts are shown by the accompanying diagram. In the table accompanying the chart the actual percentages of increase in wage levels and living costs are given.

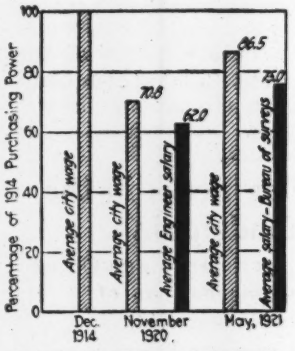
TABLE II.—MUNICIPAL SALARIES AND LIVING COSTS, CITY OF PHILADELPHIA, 1914, 1920 AND 1921

Date	Type of Services	Wage Level*	Cost of Living Level**	Purchasing Power of Average Wage	Increase in Wages* Necessary to Restore 1914 Purchasing Power
Dec., 1914	All city services	100.0	100.0	100.0	
Nov., 1920	All city services	143.6	202.8	70.8	41.2
Nov., 1920	Engineers	125.9	202.8	62.0	61.3
Dec., 1921	All city services	150.8	174.3	86.5	15.7
Dec., 1921	Bureau of Surveys	130.8	174.3	75.0	33.3

* Including the bonus. ** From U. S. Bureau of Labor Statistics

The figures show that in December, 1921, an average increase in compensation of one-third was necessary in the Bureau of Surveys (which is typical of the entire engineering service) to restore the 1914 purchasing power. This percentage of needed increase may have been slightly reduced since December by further decreases in the cost of living, but even if the purchasing power of engineering salaries were back on the 1914 basis there would still be room for improvement, since it was more or less generally recognized in 1914 that engineering pay was inadequate.

Classification an Essential to Adequate Pay—Hope to the engineer in the municipal employ in Philadelphia would seem to lie primarily through the adoption of a classification plan, particularly since under such a system the responsibilities of the job rather than the particular personality of the incumbent would be emphasized in placing the position in a grade of employment which would carry certain minimum and maximum rates of pay. The salaries proposed in the classification plan for Philadelphia are generally lower than those in Engineering Council's recommendations, but this fact is of only minor importance since the classification of the existing positions in nearly all cases provided for an increase over the existing rates of pay, and it will probably be easier in the future to raise the maximum compensation, or both the minimum and maximum, if the basic principles of classification are adopted.



LAG IN PHILADELPHIA MUNICIPAL SALARIES

Purchasing power of average city wage and engineering salaries in 1914, 1920 and 1921.

There seems to be but little hope that any classification plan for Philadelphia will be adopted in the near future, although a committee of the city council last summer did give formal recognition to the need of a proper classification about six months after council itself had taken considerable delight in kicking the report around. It is not improbable, however, that some day the demands of employees and the public will be so strenuous that attention will have to be given to the principles of equal pay for equal work, adequate pay for services rendered and opportunities for advancement to those who enter municipal employ. It would appear that national and local engineering societies could be of much assistance to municipal engineers by approving standards of classification and compensation and by carrying on a continuous program of education to secure their adoption.

Lower Truck Weights Sought in California

In explanation of the effort it will make to secure a reduction in the allowable gross weight of motor trucks when the next legislature meets the California Highway Commission has issued a statement from which the following extracts are taken: "At present the [gross weight] limit in California is 30,000 lb., which weight is exceeded by no state in the Union and equaled by only two. The average weight permitted is 22,000 lb. and is the reduced weight most generally in effect today in California counties which have passed ordinances for the better protection of their county systems. A 22,000-lb. limit will permit the free use of any 5-ton truck loaded to capacity and where the chassis and body weight is not excessive will allow from ½ to 1 ton overload beyond rated capacity. . . . The equipment which would be affected by a 22,000-lb. limit is negligible. In the United States the number of trucks manufactured with a rated capacity in excess of 5 tons is only 1 per cent of the total. Even the 5-ton type is only 2 per cent of the total. With 40,000 trucks registered in California, there would be approximately 400 trucks which would not be able to transport capacity loads and stay under a 22,000-lb. gross load limit. Existing equipment could be allowed to operate until worn out under special permits."

Two-Hinged Timber Arch Used As Temporary Railroad Bridge

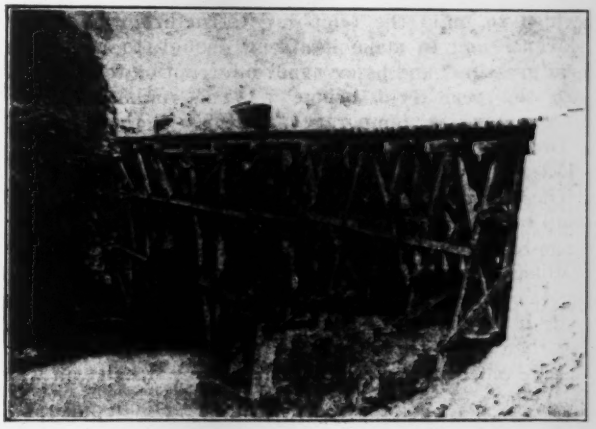
Traffic on California Logging Railroad Carried by Structure Designed as Falsework for Erecting 120-Ft. Girders

By W. J. H. Fogelstrom
Of Fogelstrom & Johnston, Consulting Engineers, San Francisco, Cal.

THE HUTCHINSON LUMBER CO. recently built a 15-mile railroad in northern California to tap a stand of some two billion feet, b.m., of timber in the Feather River basin. The line starts from the Western Pacific R.R., 7 miles east of Oroville, Cal., and follows up the Middle Fork of Feather River about 3¼ miles where a bridge across the south fork of that stream was required. Beyond this point the line rises rapidly on a 5.2 per cent grade into the timbered areas in which later extensions of the road are contemplated. Because the load is expected to be in service for a considerable period of years, a steel bridge was decided upon for the south fork crossing. Local conditions led to the selection of a 120-ft. steel girder bridge.

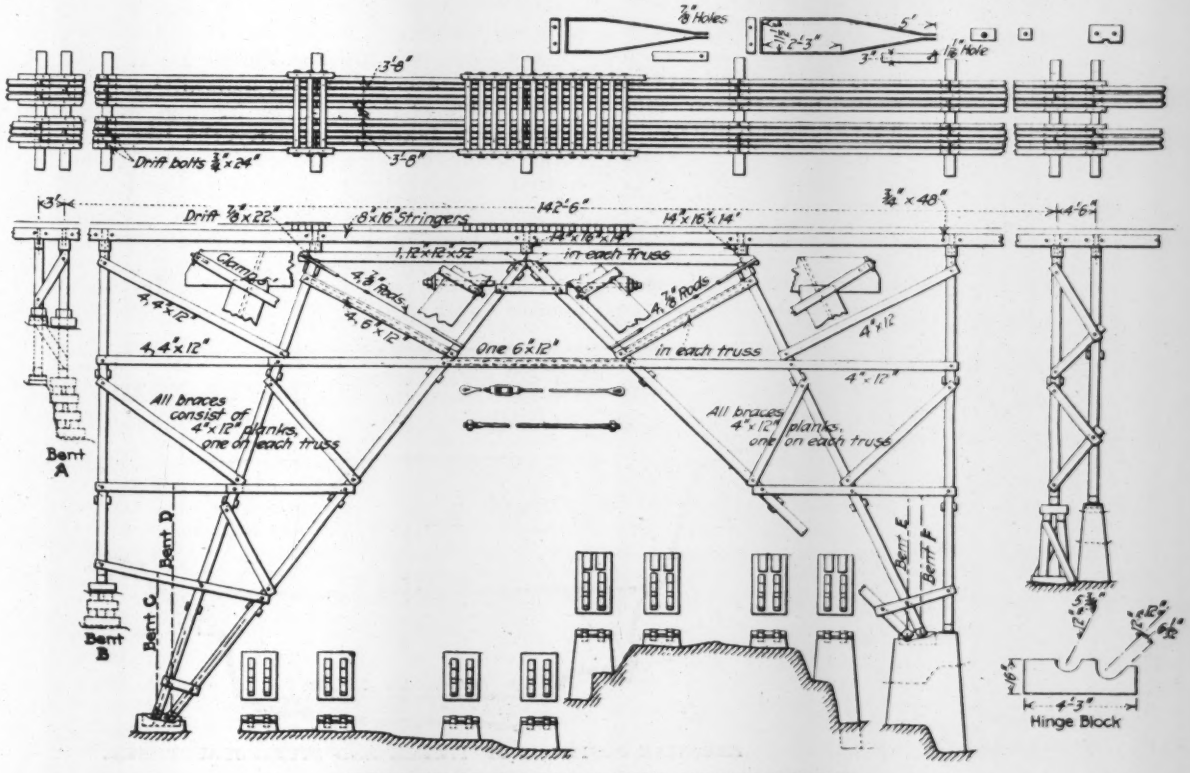
The most convenient way to get the large steel girders in place, it was decided, would be to build a timber falsework on which track could be laid at grade and over which standard equipment could operate. This would make it possible to handle the girders with a locomotive crane, setting them on concrete piers built entirely independent of the falsework. The falsework was designed and built as a two-hinged timber arch, as described herein. When the falsework was completed the immediate need of the bridge and delay in getting the steel girders erected on account of litigation resulted in the use of the temporary structure for regular railroad traffic. The fact that this has continued for some time and may become permanent attaches interest to the structural features of the bridge.

At the point where the south fork crossing is made, the base of rail has a maximum height of 72 ft. above the bottom of the river. A through girder instead of a deck girder was chosen because a dam has been projected about one-half mile below the bridge which would back water up to such a level that a deck girder would not be in the clear. The girders are to be supported on concrete piers to be built just back of and above the two footings of the timber structure. Foundations are in solid dock.



LOOKING ALONG THE COMPLETED TIMBER TRUSS

On account of the lateness of the season when the bridge work was begun and the probability of high



TWO-HINGED, TIMBER-ARCH RAILROAD BRIDGE

STRESSES IN MAIN TRUSS MEMBERS (+TENSION—COMPRESSION)

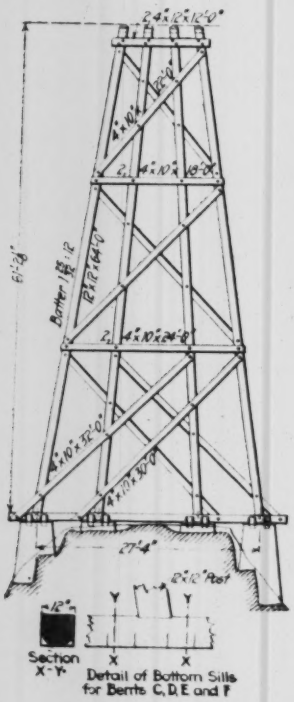
	B-C	C-D	a-b	b-c	c-d	a-B	B-b	b-C	C-c	c-D	D-d
Dead load	— 3,600	— 5,500	— 18,500	— 3,300	—13,200	— 17,900	— 2,200	— 17,400	— 11,600	— 2,600	— 18,400
Live load	—43,100	—49,700	—107,600	—40,000	—88,300	—155,600	—30,300	—125,900	—106,200	—30,000	—160,600
Live load	+29,300	+31,400	+ 7,200	+29,600	+27,700	+15,800	+25,200	+26,600	+49,400	+20,200	+ 16,600

water, which always carries a mass of floating debris, coming before the falsework could be removed, it was decided to build the temporary structure with ample clearance and to make it strong enough to resist the flood pressures and hence avoid interruption to traffic in case the permanent bridge was not finished before high water. A temporary structure in the form of a two-hinged timber arch, as shown herewith, was selected as best adapted to this purpose.

The foundation for the two-hinged arch consists of small concrete piers in which are imbedded the foot- or hinge-blocks which support the inclined bents. The footblocks have rounded grooves made to fit similar curves on the under side of the bent sills. These grooves made it possible to erect the bents in a vertical position and then allow them to swing around the footblock as a hinge until the desired inclination over the stream was reached.

By building the bents so that all outside posts and all track posts, when in their final positions,, form four longitudinal planes, it was possible to get the final alignment of the structure in such form that it made, practically speaking, four two-hinged arch trusses. The stresses given are computed by assuming the structure as a two-hinged arch. The additional braces shown in the detailed drawings were put on to stiffen the structure and tie it together; they were not included in the calculations.

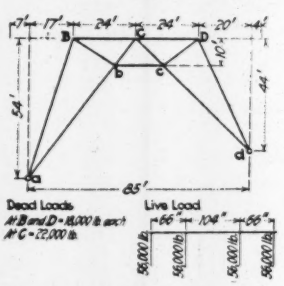
The two steel girders for the permanent bridge weigh about 50 tons each and were shipped complete, each girder loaded on three flat-cars. In addition to the weight of these girders the falsework was designed to carry the live-load stresses caused by a 112-ton crane. This live-load is distributed on eight wheels, with a total wheel base of 19 ft. 8 in. and a truck wheel base of 5 ft. 6 in. This crane, which was the only one available for the erection of the plate girders, naturally causes very eccentric loads in the falsework and is the cause of the great variation of stresses in the same members as shown in the stress table.



ELEVATION OF BENT "E"

The four posts of each bent are placed so that two-thirds of the load will come on the two track posts and one-third on the outside posts. Thus track posts each carry one-third the total load and outside posts one-sixth. All members except *B-b*, *b-c* and *c-D* are 12 x 12-in. Douglas fir; *B-b* and *c-D* are 6 x 12-in. timbers with ⅞-in. upset round rods; *b-c* consists of 6 x 12-in. timbers with 1¼-in. upset round rods.

The critical points are *B*, *C* and *D*. At *B* and *D* the rods *B-b* and *c-D* terminate in ½ x 3-in. strap iron loops or stirrups which hold the top chord, *B-C-D* tight against the post. With this arrangement when tension develops in the top chord the connections will not open. At *C* the posts are bolted with 1-in. bolts to the top chord preventing any pulling apart at that point.

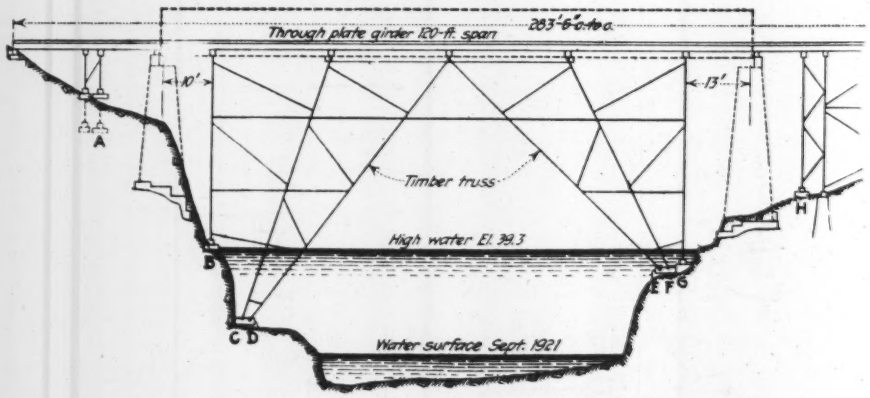


TRUSS MEMBERS FOR WHICH STRESSES WERE CALCULATED

It will be noticed on the detailed drawings that the various bents have different batters. The batters are calculated so as to give all outer posts a batter of 2½ in. per ft. and track posts 1½ in. per ft. These batters are measured in a vertical plane when the bents are in their final position with the principal members forming four longitudinal trusses. All cross bracings are also figured so as to come as nearly as possible in the same horizontal plane.

The design as shown in the drawings was made for a temporary falsework to carry the track across the gorge until the permanent steel structure could be erected. However, with some few changes and strengthening of connections it could be made a more permanent structure to serve the logging traffic regularly in case the steel span is not put in.

S. T. Norris is chief engineer of the Hutchinson Lumber Co.



RELATIVE POSITIONS OF TIMBER AND STEEL STRUCTURES

Indianapolis' Ten Million-Gallon Covered Reservoir

Groundwater Limited Depth—Groined-Arch Floor for Upward Pressure and Flat-Slab Roof for Economy—Built in 120 days

Paper Read Before the Indiana Sanitary and Water Supply Association, March, 1922, by W. C. Mabee, Assistant Chief Engineer, Indianapolis Water Co.

IN January of this year, a 10,000,000-gal. reinforced-concrete reservoir for the Indianapolis Water Co. with a groined-arch floor and a flat-slab roof was completed at a cost of $223,500. Limiting conditions as to depth were imposed by the high ground water causing upward pressure and the upper limit was fixed by the hydraulic gradient of the supply conduit. Careful cost data were kept of the various operations which were carried out by contractors on both the cost-plus and unit basis. Construction of floor columns and roof was carried on continuously from one end to the other from successive set-ups of a large portable mixing plant. No expansion joints were left. At the end-of-the-day joints special provisions for flooding were made to eliminate surface cracking.

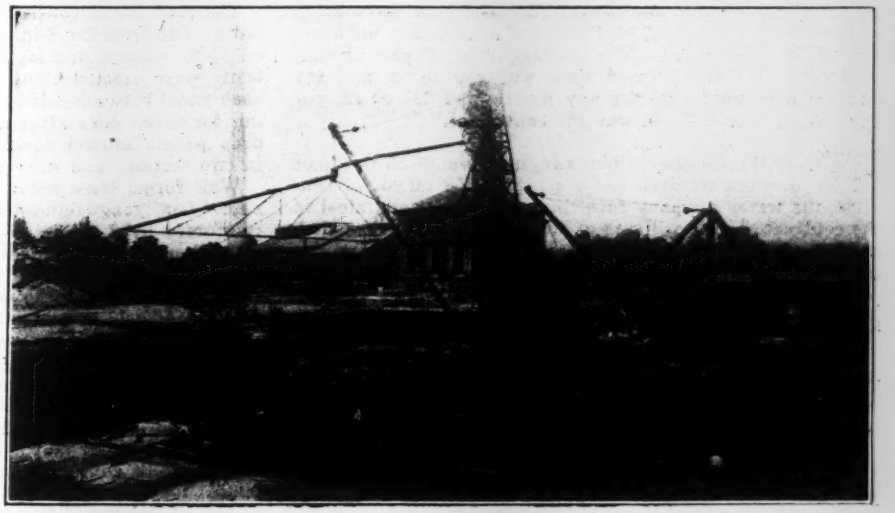
The site chosen for the new reservoir was formerly part of the open infiltration gallery at the Riverside pumping station, constructed in 1882 and abandoned as a source of supply in 1907 when the first covered reservoir at this station was built.

The reservoir is divided into three phases by two baffle walls which provide for the uniform circulation of water through all parts of the basin. The baffles are 4-in. brick walls joining columns and extending to the column heads, the walls being reinforced at the middle point of each panel by a 12-in. square brick column. Piping connections are provided so that water may enter or leave the reservoir at three points. One of these connections communicates with an adjoining reservoir of less capacity through a controlling chamber having a drain connection by means of which either reservoir may be emptied and cleaned independently. Another of these connections enters a sump or suction well making practically the entire contents of the reservoir available to the pumps. Pipe connections are 48 in. in diameter.

It was considered advisable and necessary to design the reservoir so that a rise of 10 ft. in the groundwater level would be counterbalanced by the weight of the structure and the superimposed loading of earth upon the roof of the structure without consideration of the weight of the water contained within the reservoir. This excessive upward pressure of groundwater during flood stages, calculated to be exerted at a time when the reservoir might be empty, and the necessity of an equal distribution of downward pressures upon the soil presented a problem in the design of the floor which obviously could be solved best by the employment of the groined-arch type of floor construction. Further, this type of floor forms intersecting valleys which can be flushed readily when it is necessary to clean the basin.

While a groined-arch roof would have been as satisfactory as the flat-slab type of construction adopted, experience in Indianapolis has shown that contractors as a rule prefer to build along lines with which they are familiar and will for that reason submit lower prices for the flat-slab type of construction than for the groined-arch type, notwithstanding the fact that the groined-arch roof requires practically no steel. The necessity of weighting the structure suggested the use of 27 in. of filling on the cover, assumed to weigh when saturated 250 lb. per sq.ft. This fill also prevents the formation of ice in the reservoir and tends to maintain the roof slab at a reasonably uniform temperature in all seasons, thereby minimizing the distortion of the structure from temperature changes. The total live- and dead-load considered upon the roof slab was 470 lb. per sq.ft. or a superimposed load of 350 lb. The flat slab is designed in accordance with computations based upon the rulings of the American Concrete Institute for four-way reinforcement.

The usual spacing of columns for work of this character varies from 15 to 25 ft. and for the loading under consideration the slab thickness would vary from 7½ in. for the 15-ft. spacing to 12 in. for the 25-ft. spacing; the column spacing could even be made as little as 10 or 12 ft. on centers. There is no doubt in the writer's mind that the structure with the smaller column spacing can be built for less money, but considering the groundwater problem and the desirability of heavy sections an 18-ft. spacing was adopted. The columns are 24 in. in diameter, reinforced with eight ⅞-in. round bars and ¼-in. tie-bars.



MOUNTED CONCRETE-MIXER PLANT FOR RESERVOIR CONSTRUCTION

The floor, walls and roof of this 254 x 542-ft. reservoir were poured with only eight moves of the large mixing plant. A ½-sack batch mixer was also used for the floor.

Except for corners with a 10-ft. radius, the reservoir is rectangular in plan, 254 x 542 ft., with a net water surface of 136,500 sq.ft. or 3⅛ acres. It stores about 1 m.g. per foot of depth and the depth is 10 ft. 8½ in. The cost per million gallons stored, exclusive of piping connections, brick baffle walls and engineering, but including all earth work, was $19,150, equivalent to $1.41⅛ per square foot of water surface. In percentage this cost was divided as follows.

Excavation, average cut 11 ft.	15.6
Refill, 27 in. deep on cover	7.1
Levee embankments	2.0
Concrete structure, including sub-grading	75.3

The typical labor charges per hour upon which these costs were based were as follows: Common labor, 30c; skilled labor, 35 to 60c.; form builders, 60c.; teams, 75c. All levee work was done by force account for which the company allowed the contractor cost plus 15 per cent.

Excavation—The dimensions of the excavation were 280 x 570 ft. with a cut varying from zero to 23½ ft., the average being 11 ft. The character of excavation was top soil and bank gravel. The work contemplated filling an abandoned infiltration gallery or reservoir which extended diagonally across the site for the proposed new structure with sand and gravel from the excavation and rolling the

fill with a locomotive crane, the expense of rolling being paid for on force account.

Gravel suitable for concrete was washed, screened and stored in piles upon the old infiltration gallery site at an additional cost of 40c. per cu.yd. The top soil was carefully selected and stored in piles conveniently located for top dressing embankments after completing the structure.

Excavation progressed by months at the following percentage rates: 21, 42, 15, 14, 8.

The equipment consisted of a locomotive crane operating a 1½-yd. clamshell bucket which was used to fill the old gallery and which was also used to elevate gravel to the washing platform. The larger part of the excavation was handled by teams and wheeled scrapers. The average rate of excavation for the elapsed time was 324 cu.yd. per day and the maximum rate for 30 days was 750 cu.yd. per day. Earth for refill and embankment was included in the contract for concrete work and was handled by wheeled scrapers as follows: 17,985 cu.yd. at 55c. per cu.yd.; 10,150 cu.yd. by force account at 75c. per cu.yd. The total excavation and refill, 80,130 cu.yd., cost the water company an average of 58c. per cu.yd. The average rate of placing embankments for the elapsed time was 230 cu.yd. per day and the maximum rate for any month was 293 cu.yd. per day. R. H. Scott & Co. was the contractor.

Concrete Work—Eleven bids ranging from $6.35 to $15.08 per cu.yd. were received for placing 11,158 cu.yd. of concrete, the water company furnishing all cement and steel to the contractor on board cars at the water company's switch and also delivering gravel to the site, the contractor unloading, hauling and storing cement and steel, furnishing all material for forms, centers and supports; bending settling and securing all reinforcing bars, mixing and placing concrete; fine grading and tamping the reservoir bottom.

The contract was awarded the Mead Construction Co., the lowest bidder, May 26, 1921 and was finished Oct. 24, 1921, the day before the time set in the contract for completion. The average daily progress for the elapsed time, 120 days, was 93 cu.yd. and the maximum day's work was 328 cu.yd. The maximum month was 5,323 cu.yd. In percentage the rate of progress was as follows: June, 2; July, 25; August, 48; September, 21; October, 4.

The water company furnished 15,523 bbl. of cement at a cost of $2.44 per bbl., which the contractor handled for 19c. per bbl. The 464 tons of steel bars cost the water company $2.58 per 100 lb. including the cost of bar spacers. It was placed for $15 a ton. About 5,500 cu.yd. of gravel were purchased at a cost of $1.53 per cu.yd. and 8,443 cu.yd. of gravel were reclaimed from the excavation at a cost of 47½c. per. cu.yd.

Excluding engineering the unit cost per cubic yard of concrete, all of which was a 1:2:4 mix, was: Cement $3.40; steel bars, $2.15; gravel, $1.11; labor (by contract) $6.39; total, $13.05. The labor cost of mixing and placing was $1.7133; fuel, 12; miscellaneous hardware, steel and repairs, 29c. per cu.yd. Hand grading and tamping preparatory to laying the floor cost the contractor $1.50 per 100 sq.ft.

Contractor's superintendence, field-office and bond expense are not included in the unit costs quoted but profits realized by the contractor are included.

Method of Construction—The floor was formed by a series of parabolic groined arches having a rise of 18 in. on a span of 15 ft. 8 in., a minimum thickness of 9 in. and a maximum thickness of 27 in. at the columns. The column base is 28 in. square. In construction, the floor was divided into two parts; the lower 4 in. was laid first as a mat, reinforced with ½-in. bars spaced on 12-in. centers in two directions; this mat served the double purpose of a waterproof membrane and as the foundation for the groined-arch upper floor section.

The roof slab is 9 in. thick and has drop panels at the column heads 6½ ft. square extending 5½ in. below the bottom of the slab. The columns and column heads are circular and were formed by special metal forms rented by the contractor. The cost of setting the 420 column forms was $2.03½ each. The rental of column forms sufficient to form 10 per cent of the columns at once and the purchase of floor screeds distributed over 420 columns amounted to $6.32 each.

The walls are 15 in. thick and rest upon a footing 9 in. thick extending 12 in. outside of the outer wall line, the vertical reinforcement having its anchorage in the floor and roof slabs. The walls at the corners of the reservoir are curved to a radius of 10 ft., this expedient having been found successful in the elimination of contraction cracks at points where such cracks are usually found troublesome. Reinforcement for temperature stresses in the walls consisted of ⅝-in. round deformed bars spaced on 12-in. centers in each face. The form lumber necessary to construct 18 per cent of the wall length and 15 per cent of the roof surface, including supports for 27 per cent of the roof surface distributed over the entire surface formed, amounted to 5c. per sq.ft. The cost of forming labor for the roof surface was 11.5c. per sq.ft. and for the wall 5.7c.

The roof forms consisted of a series of bents or trussed units made from 2 x 8-in. planks doubled, which were spaced on 3½-ft. centers and lagged with 2 x 8-in. planks. These bents were erected upon wedges. At the center point of each panel between columns a 4 x 6-in. prop was left standing for seven days after the centers had been struck. The drop panels around columns were made of wooden units in two sections and were used seven times.

Wall forms were made in unit sections each 4 ft. wide using ¾-in. tongue-and-groove sheathing placed vertically, reinforced by 2 x 6-in. ribs placed longitudinally and with wood flanges at the sides for bolting the sections together. The 4 x 6-in. horizontal walings, spaced on 24-in. centers, were bolted through the wall at intervals of 30 in. by ⅝-in. round rods held by set-screw clamps. These rods were left in place until after the removal of the forms.

Equipment—The contractor's equipment consisted of one 18-cu.ft. mixer mounted upon a platform forming the base of a tower 74 ft. high and located under a charging hopper or bin holding 45 cu.yd. of gravel. The tower supported one concrete chute 30 ft. long and two counter-balanced chutes, one 40 ft. and one 50 ft. long, giving a working radius of 120 ft. This mixer plant was mounted on rollers for convenience in moving. The chute system was manipulated from a 70-ft. boom attached to the base of the tower and the elevating bucket operated by a single-drum hoisting engine. The hopper was charged by means of a two-drum hoisting engine operating a stiff-leg derrick mounted on rollers and having a 70-ft. boom and ¾-yd. clam-shell bucket. In addition to this outfit the contractor used a ½-sack batch mixer for placing floor concrete.

The larger mixing plant was placed first in the center of one end of the structure and then moved eight times down the center to the opposite end, finishing floor, walls and roof as the derricks moved along. Day-joints were properly bulkheaded and keyways left in all bulkheads. immediately upon the completion of one portion of the roof the margins of the day's work were dammed with a small mortar edging and water about 1½ in. deep was permitted to fill the inclosure. This procedure eliminated surface checks by keeping the fresh concrete saturated and also tended to keep the temperature of the concrete from rising during the hot days of mid-summer. No expansion joints were provided, dependence being placed upon the steel bars, keyways and the density of the concrete mixture to produce a monolithic and waterproof structure. The centers were removed seven days after pouring a section of roof slab. However, one 4 x 6-in. prop was left in the center of each span between columns in two directions. In seven days more these props were removed and in two more weeks, or 30 days from date of depositing the concrete, the earth fill was distributed over the roof in layers 7 to 10 in. deep. The work was done in midsummer when weather conditions for curing the concrete were most favorable.

The work was carried out under the direction of B. J. T. Jeup, chief engineer, Indianapolis Water Co. Leonard Metcalf, Boston, was consulting engineer.

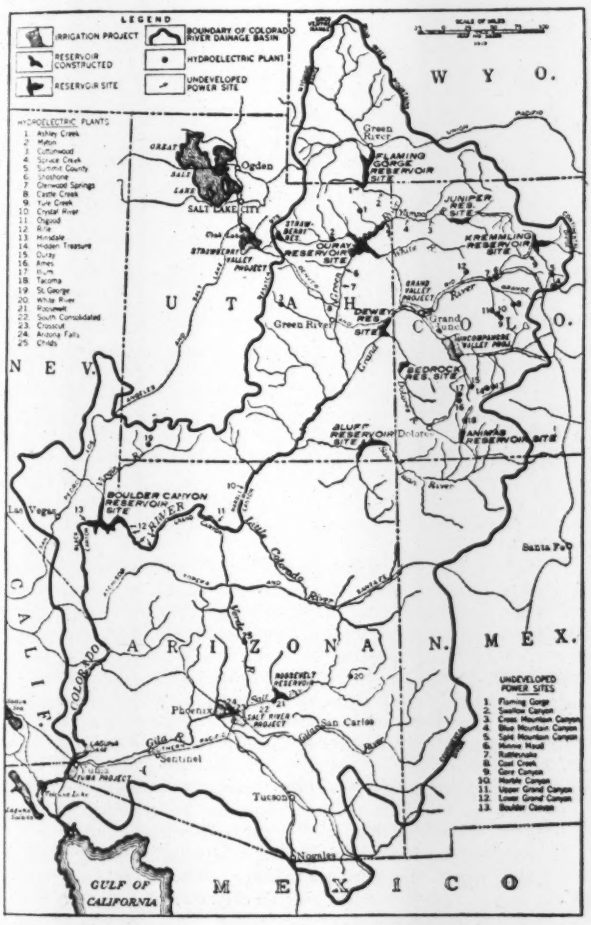
The Colorado River; Its Control and Development

Hydraulics of the River and the Demand for Power, Flood Control and Irrigation Subject of a Federal Report—Recommends Boulder Canyon Dam and All-American Canal in Imperial Valley

Pursuant to the act of Congress approved May 18, 1920, and known as the Kincaid Act, the United States Reclamation Service has been carrying on an extended investigation of the hydraulics of the Colorado River and the problems of its development to satisfy the threefold necessities of irrigation, power and flood control. The final report has just been made by Director Arthur P. Davis, and has been transmitted by the Secretary of the Interior to Congress. The report is only a part of the many data on file with the Reclamation Service, which will be utilized in the current study of the Colorado River problem now being conducted by the Colorado River Commission under the direction of Secretary of Commerce Hoover. The major features of the report, including the hydraulic data, the recommendations as to the Boulder Canyon dam which, if built, will be the highest dam ever attempted, and the solution of the Imperial Valley flood situation recommended by the committee, are included in the following abstract.

THE control of the floods and development of the resources of the Colorado River are peculiarly national problems for several reasons:

1. The Colorado River is international.
2. The stream and many of its tributaries are interstate.
3. It is a navigable river.



MAP OF COLORADO RIVER BASIN SHOWING PROPOSED DEVELOPMENTS

4. Its waters may be made to serve large areas of public lands naturally desert in character.

5. Its problems are of such magnitude as to be beyond the reach of other than national solution.

Physiographic Features.—The Colorado River is formed by the junction of the Grand (now called the Colorado) and Green Rivers in southeastern Utah. Its length from the junction of the Green and the Grand to the Gulf of California is about 1,050 miles, thus making, with the continuation of the Green, 1,750 miles in length.

The drainage area of the Colorado River is 244,000 square miles, distributed as shown in the accompanying table, which also shows the water supply from the various branches:

TABLE I. AVERAGE DISCHARGES OF THE COLORADO RIVER SYSTEM.

	Per cent of total discharge.	Discharge in acre-feet.	Square miles.	Per cent of total square miles.	Acre-feet per square mile.
Green River	32	5,510,000	44,000	18	125
Upper Colorado (Grand River)	40	6,940,000	26,000	11	267
San Juan River	14	2,700,000	26,000	11	104
Other areas except Gila	8	1,560,000	91,000	37	17
Gila	6	1,070,000	57,000	23	19
Total	100	17,780,000	244,000	100	73

Observations of silt carried have been taken periodically at Yuma just below the mouth of the Gila River for a long series of years and show an average annual amount by volume of 113,000 acre-feet, on the assumption that 85 lb. of dry matter is equivalent to a cubic foot of solid.

The silt content of the Colorado, with the Gila not in flood, has averaged about one-half of 1 per cent and this is fairly representative of the silt conditions at Boulder Canyon reservoir. The discharge at Boulder Canyon is estimated at 17,500,000 acre-feet annually. On this basis the average annual silt discharge is about 88,000 acre-feet per annum.

Irrigation Requirements.—In the valleys of the Lower Colorado, and especially the Imperial Valley, storage is needed for the extension of irrigation and for safety against drouth of the areas already irrigated when the cycle of low years rolls around.

The need is also vital for protection from floods of the Colorado which threaten the levees along the river valley and which are a constant menace to the Imperial Valley, threatening a repetition of the experience of 1906. Both of these problems are urgent and vital.

The records of the Imperial Irrigation system show that for a considerable period in 1915 the waters of the Colorado River were all, or practically all, diverted at the intake of that canal and applied in irrigation of Imperial Valley, with the result that an actual shortage existed there part of the time. The shortage was not severe nor disastrous but it had a value as indicating the actual state of the water supply in relation to use. The shortage would have been still greater had a period as low as that of 1902 and 1903 occurred at that time.

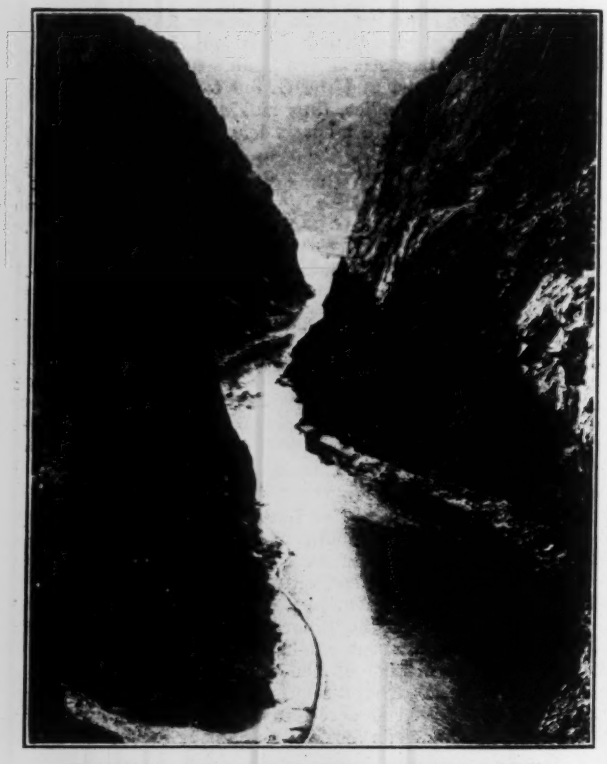
Since 1915 there has been considerable improvement in

the application of water in the Imperial Valley, but recent experience shows that storage is needed to supplement the low-water flow before any large irrigable areas can be added.

Since 1915 Imperial Valley has increased its irrigated area over 60,000 acres in the United States and about 150,000 acres in Mexico. The Imperial Irrigation District contains more than 100,000 acres of irrigable land not yet irrigated and the same valley in Mexico can increase over 40,000 acres and is in a physical position to take the necessary water from the Imperial Canal before it reaches the California line.

The increased irrigation in the basin in 1920 over 1915 is about 300,000 acres and the desired expansion in the Imperial Irrigation District and incontestable or unpreventable expansion in other regions will bring this acreage up to 877,000 acres, or about 400,000 acres more than in 1915, besides the various increases in the Upper Basin.

For full development of all the lands that can be reached by gravity and reasonable pumping lifts on the Lower Colorado River large storage capacity will be required,



BOULDER CANYON ON THE COLORADO RIVER

Here may be built the highest dam ever attempted, at least 500 ft. high and with possibilities of many hundred feet more.

estimated at about 11,000,000 acre-feet if provided by a reservoir below the Grand Canyon in the Colorado. If storage is provided above the Canyon, this must be increased by at least 2,000,000 acre-feet on account of the unavoidable losses due to the impossibility of regulating the flow in exact accordance with the needs of irrigation from a reservoir so far distant, and for other reasons.

Flood Control.—To remove the menace of flood from the Colorado River will require a much larger storage capacity than that above given.

The floods divide themselves naturally into two general classes, those from the Colorado River, which drains large areas in Wyoming, Colorado, New Mexico, Utah, and Arizona, and those from the Gila, which lies mostly in Arizona and partly in New Mexico and Mexico.

A reservoir site of 2,200,000 acre-foot capacity has been investigated near Sentinel, on the Lower Gila, which, if built and maintained, would practically eliminate the menace from the floods of the Gila, but the investigations show such poor conditions for foundation and abutments that the feasibility of this reservoir is subject to doubt.

The control of the Colorado River proper is, however, the main element involved in the flood menace of the lower river, and this has been investigated extensively.

Possible reservoir sites have been found on the Grand and the Green Rivers which, if constructed and operated for the purpose of flood protection, would greatly reduce the volume of the floods, for though the areas intercepted by each are small compared with the total area of the Colorado River Basin they drain mountains with high precipitation that furnish a relatively large volume of water. A reservoir site also exists on the San Juan River, which is the next tributary of importance, but the feasibility of this has not been established.

Of the total area drained by the Colorado River—244,000 square miles—96,000 square miles are drained by the Grand, the Green, and the San Juan, which, though draining less than two-fifths of the total area, furnish approximately 84 per cent of the total water supply. There is still, however, an area of nearly 100,000 square miles below these rivers, exlusive of the Gila, which would be uncontrolled by such reservoirs. These areas, though furnishing a relatively small quantity of water, owing to their aridity, are yet of such extent and declivity that they furnish occasional floods of magnitude from direct precipitation, due to which their control is important from the standpoint of the flood menace.

In the study of this problem, it has been demonstrated that for several reasons it is desirable to have a reservoir below the Grand Canyon of the Colorado, which will intercept most of the drainage of the Colorado River and therefor be a more complete solution of the flood-control problem. This method of control is still more vital for other reasons.

Upper vs. Lower Reservoirs.—The large areas of very fertile and valuable lands now developed and being rapidly developed require immediate relief by extension of storage for irrigation, and if such storage is constructed in the upper basin, it will of course be operated in conformity with the requirements of irrigation in the lower valley as nearly as this can be predicted, but a large percentage of the water will be lost owing to the great distance and the impossibility of predicting the exact requirements a month or more ahead. In order to provide against embarrassing shortage, it will be necessary to turn out at all times sufficient water to provide for the most extreme conditions that may occur, but which seldom do occur, and this will mean that nearly all the time a large amount of water will be flowing to waste. A large part of this waste can be obviated by an adequate reservoir on the lower river.

In addition to the above waste, any water supply appropriated above for use in the lower valley would not be available for irrigation in the upper valley. The most feasible sites occur at points where this would be an objection to such use, because it would leave in an arid state lands that might otherwise be irrigated in the upper basin. Such a result would be a distinct waste of resources, as investigations show that there is a sufficient quantity of water to furnish an adequate supply to all of the lands in the basin that can be feasibly reached by gravity or reasonable pumping lifts. There will, of course, be local exceptions to this where the areas can be reached only by tributaries in which the local supply is insufficient.

In addition to the above waste, the regulation of waters from the upper river in accordance with irrigations needs in the lower valley would be distinctly out of harmony with the best use of these waters for power in the canyon regions where the power resources predominate.

In the upper and lower regions of the Colorado Basin irrigation interests should and must predominate, although power resources are very important. In the middle or canyon region of the basin, power resources predominate and irrigation interests are small. In general, where irrigation interests are practicable, they should be given preference

over power interests, and this rule requires storage of water in Boulder Canyon, or below, for the use of the lower valleys. The states in the upper basin are therefore vitally interested in seeing that such development takes place before the natural resources are depleted by storage above for use in the lower valleys.

Likewise the states containing the lower valleys are interested in having storage in the lower basin on account of the economies thereby obtained and the greater convenience and ease of control of a reservoir near the point of use. Incidentally, it will have large power resources, which are important in the development of the resources of the Southwest.

Boulder Canyon Dam.—Fortunately, the investigations at Boulder Canyon have shown the feasibility of a high dam at that point, which if built would furnish storage as shown in the accompanying table:

TABLE II—CAPACITY OF BOULDER CANYON RESERVOIR.

(Computed from original plane-table sheets; scale, 2 in. equals 1 mile.)

Contour elevations.	Area. *Acres.*	Capacity. *Acre-feet.*	Contour elevations.	Area. *Acres.*	Capacity. *Acre-feet.*
700	.....	.....	1,100	67,740	10,153,000
750	2,350	58,750	1,150	84,110	13,949,250
800	7,950	316,250	1,200	105,100	18,679,500
850	15,260	846,500	1,250	127,660	24,498,500
900	21,620	1,818,500	1,260	131,000	26,000,000
950	29,160	3,088,000	1,280	142,000	28,600,000
1,000	39,690	4,609,250	1,300	152,000	31,600,000
1,050	53,160	7,130,500			

Note.—The canyon walls extend up to above the 2,000-foot contour, or about 700 feet higher than the last one for which capacity is calculated.

Borings have been prosecuted at the proposed dam site in Boulder Canyon and the cross section of the canyon has been fairly well worked out. A large amount of additional borings is, however, necessary to develop the entire foundation of the proposed dam and this will probably modify its location. Similar information is also necessary for the coffer-dam which must precede the main construction, and must be, for temporary work, of a rather substantial character. Results of the borings indicate the maximum depth to bedrock of about 135 ft. below low-water level. This is regarded as feasible, although the foundation work will of course be difficult and expensive in view of the great volume of the river when in freshet.

Various studies have been made on the basis of the information available and these studies indicate the cost of a dam, with flow line at 1,230 ft., to be about $45,000,000. This would have a storage capacity of about 21,000,000 acre-feet. Increased height of dam to provide greater storage can be provided at an additional cost of about one dollar per acre-foot for the next 10,000,000 acre-feet. A capacity of 31,000,000 acre-feet would require a flow line at about 1,296 ft. above sea level.

These figures include preliminary work and the completion of the dam in shape to serve for storage purposes and upon which to install power plants, but do not include any other cost of power development or transmission.

(A description of alternate methods of constructing the Boulder Canyon dam is included in an article by Arthur P. Davis, which appeared in *Engineering News-Record* of Feb. 2, 1922, p. 184.)

The High-Line Canal. — The construction of a high-line canal connecting Laguna Dam with Imperial Valley was investigated and reported upon by a board representing the State of California, Imperial Irrigation District, and the United States, under date of July 22, 1919, and was published under the title, "Report of the All-American Canal Board. A canal located entirely within the United States from the Colorado River at Laguna Dam into the Imperial Valley, California." Reference is made to that report for the details of such a plant.

Power Development. — The development of power at the Boulder Canyon reservoir is a byproduct, which does not in all respects conform to the requirements of irrigation, but can be made to conform thereto with some adjustments. The extremely arid and semitropic character of the lands in the Lower Colorado Basin makes it necessary to irrigate throughout the year, and the irrigation requirements therefor conform more nearly to the requirements for power than do those in northern latitudes.

It is estimated that the feasible irrigation projects in the lower basin, which would divert water from the main stream, comprise 2,020,000 acres, of which about 60 per cent is in the United States and 40 per cent in Mexico. The full development of the proposed projects in the upper basin will subtract substantially from the total water supply, but there will still be left ample water to irrigate all the lands of the lower basin if it is conserved and regulated in a storage reservoir of ample capacity. With 1,505,000 acres of land in the lower basin irrigated and with a total storage capacity at Boulder Canyon of 31,400,000 acre-feet, of which the lower 5,000,000 is reserved for silt storage and the upper 5,000,000 is reserved for flood control, it is possible to develop over 700,000 firm horsepower. With the entire 2,020,000 acres of irrigable land developed in the lower basin the possibilities are still 600,000 firm horsepower, and besides this there is a large amount of secondary power which is not constant but will be of considerable value.

All this is on the assumption that the total area of irrigable land in the upper basin is irrigated, namely, about 4,000,000 acres, of which about three-eights is now under ditch. The development of the upper basin will doubtless proceed steadily, but it will be a long time before the full development is reached and the water later to be consumed by future irrigation will be available for power at Boulder Canyon until that development is realized. This will greatly increase the figures shown above for a long time to come and, in the meantime, any regulation of the river above for any purpose will also tend to increase them.

The great value of this power and the wide demand for it, together with its magnitude, indicate that the power privileges of the Boulder Canyon reservoir can be made to bear the entire cost of the dam.

The markets for power are numerous and various in this part of the country consisting in general of the mining interests in Arizona and Nevada, the pumping requirements of the Colorado River valley, and the needs of municipalities of Arizona and southern California for municipal and commercial uses. Possible municipal customers of importance are Prescott, San Diego, Riverside, and Los Angeles.

The last named city has indicated a desire to share in this development. It has already developed considerable power on the Los Angeles aqueduct and owns a system for distributing electric current within the city limits. The demands, present and prospective, are far beyond the capacity of the city to supply with the present facilities and this is considered the most effective and extensive of all the power demands.

It is desirable, of course, to extend to all customers who desire to share in this development the same privileges. The use of the name of the city of Los Angeles is merely typical of such cities as may eventually elect to share in this development. Others may later apply and should have equal privileges.

Comparison of Reservoir Sites.—The demand for a large regulating reservoir on the lower Colorado is urgent and imperative, first for regulating floods and, second, for providing storage water for irrigation, and, third, for power. Without the power the reservoir is not feasible at all as the expense would be too great to be borne by other interests alone.

The reservoir site provided by a dam at Boulder Canyon is the lowest point on the Colorado River where a site of sufficient capacity can be found. Above this site the Grand Canyon occurs and no reservoir of a capacity sufficient to control the entire flow of the river occurs until we reach a point above the Grand Canyon National Park. A site has been proposed above the mouth of the Paria River in Glen Canyon, and it has been urged that a reservoir formed here would, for a given height of dam, provide greater storage capacity and would so regulate the floods as to facilitate the construction of other dams farther down. These are

valid arguments as far as they go, but such a reservoir would not answer the present purposes for several reasons. Between the Glen Canyon and Boulder Canyon site about 50,000 sq.mi. of drainage flows into the Colorado, including the Little Colorado, the Virgin, the Paria, the Kanab, and many smaller tributaries. This region furnishes about 10 per cent of the water supply passing Boulder Canyon and most of it is subject to torrential summer rains and to floods at other times, and the Glen Canyon site would not therefore give satisfactory control of the floods, which is the most urgent of the problems presented. A satisfactory solution of this problem could not be accomplished at any point above Boulder Canyon.

Any large reservoir on the Colorado must depend for its financial feasibility upon the availability of an adequate market for not less than one-half million horsepower of electric energy within economical transmission distance. The principal available markets are the Pacific slope of California, irrigation pumping, the mining regions of Arizona, electrification of the Southern Pacific, the Santa Fe, and the Salt Lake Rys., and cities in Nevada, Utah, Colorado, and New Mexico. All of the more important markets above listed are more convenient to Boulder Canyon than to Glen Canyon. This is especially true of the most important markets, the cities and irrigation districts of southern California. To reach these the most feasible route for transmission lines, considering the importance of transportation and their construction and maintenance, is approximately along the railroad routes. [Averaging up these distances, a table shows the difference in favor of Boulder Canyon to be 264 miles.] This advantage in transmission distance is of course decisive. It would be hard to find a power site in the United States more remote from adequate markets than the Glen Canyon site.

As regards silt problems, the Boulder Canyon dam as planned would store the silt for over three centuries if all were caught and held, and for nearly a century before greatly impairing its water storage function.

Recommendations — At the conclusion of the report the following recommendations are made:

1. It is recommended that through suitable legislation the United States undertake the construction with Government funds of a high-line canal from Laguna Dam to the Imperial Valley to be reimbursed by the lands benefited.

2. It is recommended that the public lands that can be reclaimed by such works be reserved for settlement by ex-service men under conditions securing actual settlement and cultivation.

3. It is recommended that through suitable legislation the United States undertake the construction with government funds of a reservoir at or near Boulder Canyon on the lower Colorado River to be reimbursed by the revenues from leasing the power privileges incident thereto.

4. It is recommended that any state interested in this development shall have the right at its election to contribute an equitable part of the cost of the construction of the reservoir and receive for its contribution a proportionate share of power at cost to be determined by the Secretary of the Interior.

5. It is recommended that the Secretary of the Interior be empowered after full hearing of all concerned to allow the various applicants their due proportion of the power privileges and to allocate the cost and benefits of a high-line canal.

6. It is recommended that every development hereafter authorized to be undertaken on the Colorado River by the federal government or otherwise be required, in both construction and operation to give priority of right and use—

1. To river regulation and flood control;
2. To use of storage water for irrigation;
3. To development of power.

Rochester Begins Work of Making Subway Out of Erie Canal

Abandoned Section of Canal Bed Being Fitted for Rapid-Transit Service and Vehicular and Pedestrian Traffic

BY EDWIN A. FISHER
Consulting Engineer to the City of Rochester, N. Y.

RECONSTRUCTION by the city of Rochester, N. Y., of a portion of the abandoned Erie Canal to fit it for rapid-transit service and vehicular and pedestrian traffic began early in April. Through the construction of the Barge Canal, south of the center of the city, a 13-mile section of the Erie Canal has been vacated, and 8⅓ miles of that section were acquired late last year by the city to be used as the basis of a rapid-transit system.

The reconstruction contemplates the placement of four main tracks, together with sidings where required, on the canal property at the grade of the canal bottom. Two tracks will be for freight and will eventually be connected with all the railroads in the city as well as with industries either located or to be located along the line of the canal. The other two tracks will be for interurban and local trolley service, and will connect with all interurban lines, thereby permitting the removal of interurban cars from surface streets. Above the canal bed will be constructed a superstructure for

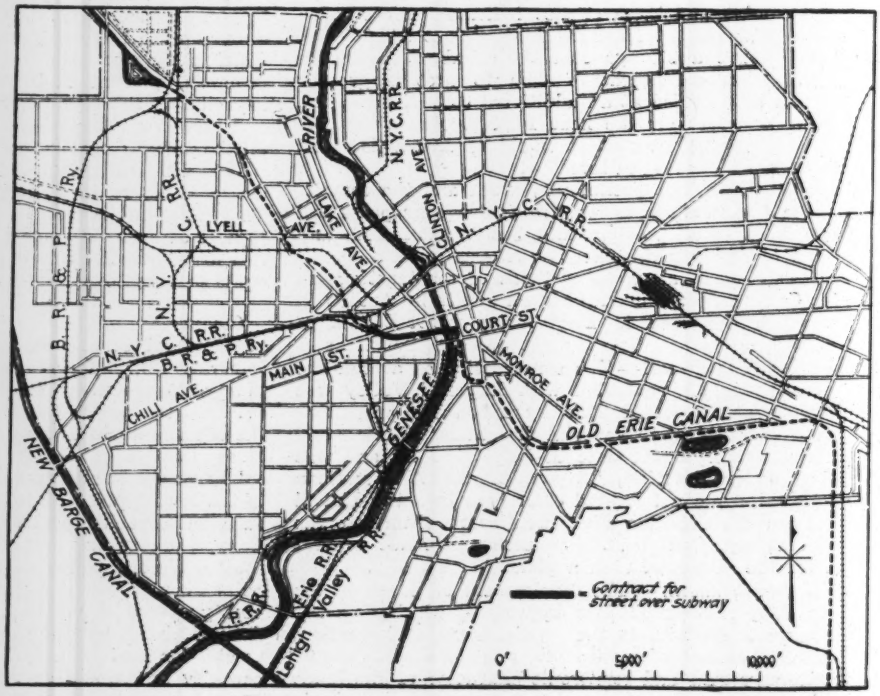


FIG. 1. ROUTE OF ABANDONED ERIE CANAL THROUGH THE CITY OF ROCHESTER

vehicular and pedestrian traffic. The width of the street will be from 52 to 60 ft., and the sidewalk 14 to 18 ft.

The particular contract now being executed is for work extending from Oak Street on the west to Court Street on the east.

The aqueduct which carried the waters of the Erie Canal across the Genessee River is to retain its general character in the reconstruction. The railroad will be

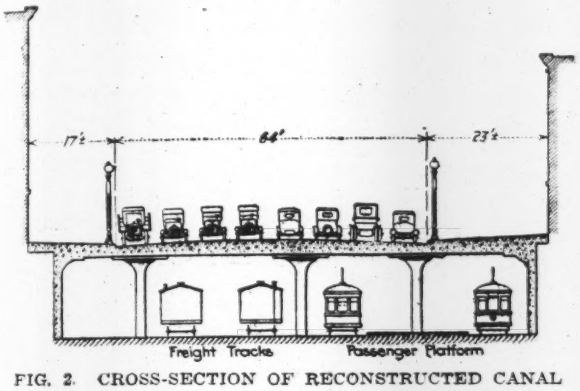


FIG. 2. CROSS-SECTION OF RECONSTRUCTED CANAL

built inside of the aqueduct and the street surface on the masonry structure on top of the present parapet walls.

Three main stations are provided within the city, and other stations are located as shown on the accompanying general map of the city. At these stations the tracks are to be spread a distance of 30 ft. from center to center, leaving a platform on either side 29 ft. in width.

The ordinance which was passed Nov. 21, 1921,

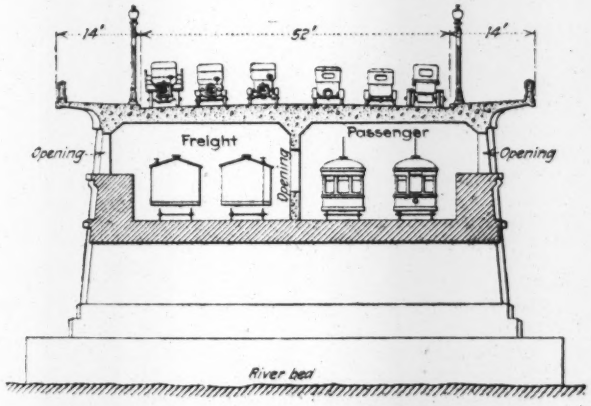


FIG. 3. SECTION OF NEW STRUCTURE OVER GENESEE RIVER

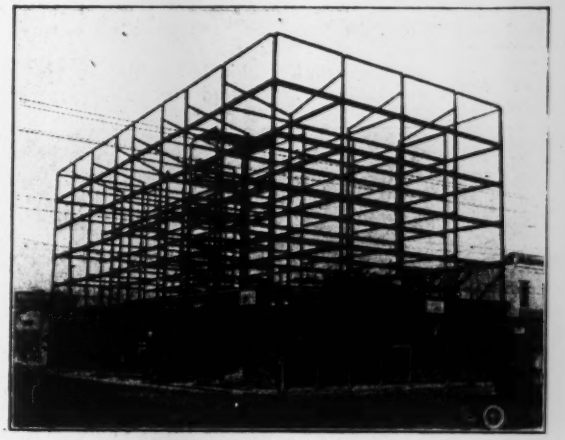
authorizing the construction of the subway and superstructure through the main part of the city also authorized a certain amount of excavation necessary to connect the proposed subway with the Lehigh Valley R. R. on the east, and with the B. R. & P. R. R. on the west, a total distance of about one mile.

The price paid for the abandoned section of the Erie Canal by the city was $1,500,000 in round numbers. The contract for building the subway and the superstructure was let recently to Scott Bros. of Rome, N. Y., for $1,183,780.

The detailed study of the project was made by Legrand Brown under the general direction of Edwin A. Fisher, consulting engineer and superintendent of city planning. The detailed plans of the portion of the work recently let were prepared by Mr. Brown under the general charge of the city engineer, C. Arthur Poole. B. H. Davis, New York City, was the consultant on concrete construction. Prof. George F. Swain of Boston examined and reported favorably on the entire project. The general plan was also approved by the City Planning Bureau.

Sixty-Foot Columns Economical in Five-Story Building

IN erecting a five-story steel-frame office building at Santa Rosa, Cal., considerable time was saved in detailing, in shop work and on erection by the use of columns 60-ft. long. Using columns of this length no splices were required above the second floor and above this level it was not necessary to plank entire bays for riveting. Another item of delay eliminated was the necessity for repeated raising of the derrick as is the ordinary procedure when erecting two stories at a time. There



VERTICAL COLUMNS WITHOUT SPLICE ABOVE THE FIRST STORY

was no difficulty due to kinked columns and very little pulling by cable and toggle had to be done.

Sixty feet is a popular length for steel shapes carried in stock on the Pacific Coast because, 20, 30 or 40-ft. lengths can be cut therefrom without waste. For this job H-columns of the 60-ft. length were selected of a weight sufficient to give the required strength at the lower end. The weight of the splice material and the shop cost saved by the elimination of splices more than made up for the added material used by making the columns the same sectional area through all stories above the first. The first-story columns had to be of a considerably heavier section. The 60-ft. length was sufficient to extend from the second floor into the parapet, the latter adding practically a sixth story.

The foregoing was supplied by Clarence E. Seage who was consulting engineer on the job. Sylvain Schnaittacher was the architect and Al Coutts the erector. Credit for aiding in the deviation from ordinary methods is given to the Central Iron Works by whom the steel was supplied.

LETTERS TO THE EDITOR

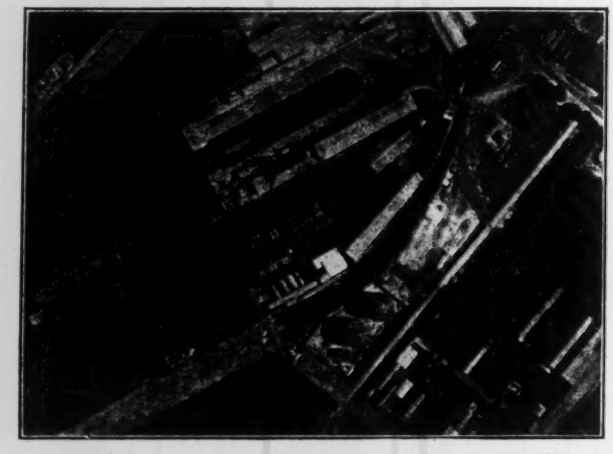
This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

In Support of Aerial Surveys

Sir—With reference to P. J. Barry's letter in your issue of Nov. 17, 1921, p. 828, I would like to challenge his statements in regard to one or two points.

On perusal of Mr. Barry's letter it is evident that he has had little or no experience in aero-survey work. That "the results achieved during the war . . . only served to demonstrate that for all practical purposes the making of maps from photos is impossible" is a futile statement to make. Had Mr. Barry been in the Army Zone—and no man who was there would underrate the value of aero photography—he would have seen whole maps prepared from air photos for the artillery and actual shots carried out from them alone. If this is not a "practical application" I would draw his attention to the fact that all trenches shown on service maps were plotted from air photos and were just as accurate when plotted to a scale of 1:10,000 as the same trenches determined with all the theodolites and chains that Mr. Barry can manage to collect. For a sample of mapping done from the air I would refer Mr. Barry to any British ordnance map showing enemy and British trenches in, say, the Ypres salient.

In the second paragraph of his letter Mr. Barry refers to the different altitudes flown and the subsequent disastrous results to the photos obtained. Investigation of Mr. Barry's sketch on p. 828 will show that he has assumed the plane to be flying at 1,000 ft. I would like to point out that, unless under exceptional circumstances, the average height for a photo is between 4,000 and 8,000 ft. and that a photo taken at 1,000 ft. for survey use is practically useless.



MELBOURNE DOCKS PHOTOGRAPHED AT HEIGHT OF 4,000 FT.

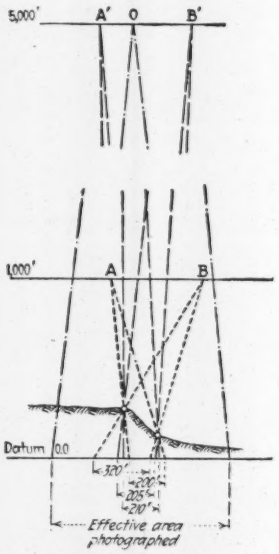
At a height of 5,000 ft. or more the error referred to is practically eliminated and decreases as the height increases. Again, the middle third of the photo only is used and with increased altitude the error at a scale of 1:10,000 is negligible. The accompanying drawing shows the advantages gained in flying at high altitudes. I also enclose a photo taken at a height of 4,000 ft. of some of the Melbourne docks. This photo has not been specially selected but is one of many covering some 20 sq. miles of docks and part of a mosiac map prepared for a local department.

Mr. Barry expresses his sympathy with the draftsman called upon to trace the mosiac. I employ a process where no tracing is required in making a line plan from the photos, so no draftsman need be heartbroken.

That "the day of the airplane as a survey instrument has not arrived" is a rather prodigal statement to make as the Shaw Ross Aviation Co. of this city is making surveys of country hitherto untouched by the theodolite methods, showing, forests, rivers, spurs, and all topographical detail, but of course giving no levels.

As the greater part of Australia is, up to the present time, unsurveyed and as the only feasible way of doing it is from the air, I would ask Mr. Barry to watch the development of aero survey in this country and he may then, perhaps, refute some of the wild assertions made in his letter.

HUNTER ROGERS,
Engineering Branch,
Public Works Department,
Melbourne, Australia.



ERROR REDUCED BY FLYING AT HIGH ALTITUDES

Sir—The article entitled "Uses of Aerial Photographs in Map Making" by Glenn S. Smith, U. S. Geological Survey *(Engineering News-Record,* Feb. 2, p. 194*)*, deals rather severely with what is described as "ground methods" of topographic surveying. The author could have maintained a much safer position, however, if he had explained that the methods referred to were merely those which came under his own personal observation, instead of leaving it to his readers to infer that the allusions were meant for all survey methods. Comparison with maps which are not complete and are only in the class of sketch maps does not show that aerial photographs are superior to maps based upon precise field surveys, and it is with the latter comparisons must be made to prove anything conclusive.

On p. 194 we are told that "the data obtained from air photographs are far more complete, and in most cases more accurate, than are obtained by means of ground surveys." And at the conclusion of the same paragraph it is stated that "the wealth of information shown in the photographs and the availability of this information for reference makes this method of securing survey data superior to the ground methods." Does the writer seriously inform his readers that they will obtain more accurate information about map details at a distance of two miles from them than can be got by a close inspection? Or, that a process which has no mathematical values is superior to the actual and calculated measurements of a precise plane survey? It is too much!

The frequent references in the article to a 1-in. map and engineering requirements causes the reader to wonder where the connection is, because it is not very evident that a mosaic map without contours or elevations and upon which 1-in. represents 5,280 ft., can be of much use to engineers; it fulfils no requirements beyond being a guide map. The statement that "any *method* employed in making ground surveys is subject to errors" is very wide of the mark, if its meaning is taken from the context. In countries where it is absolutely necessary to have accurate surveys made, the original survey is not taken for granted, and a system of examination is applied which ensures that field and office errors are eliminated before printing.

For reconnaissance purposes and certain classes of outline maps aerial photographs are often useful, but as a substitute for the regular methods of topographical surveying, when accuracy and clearness of detail are essential, they are of little practical use. In examining the claims of aerial mappers it is only too evident that they are very much exaggerated. For example: Mr. Smith admits that

a mosaic is not a map because the features shown on it "are in no case in their correct relative position to all others shown on the mosaic." They are subjected to a process of adjustment (which is not explained) in order to agree with points which are assumed to be in correct position.

So much being admitted, the characteristics which make a map intelligible may be briefly dealt with. These requirements are classified under six headings: (1) Boundaries; (2) names; (3) altitudes; (4) areas; (5) geology; (6) detail. The first five can be dismissed as having no connection with aerial photography because the data under these headings will have to be collected on the ground. It may be claimed that (4) areas can be taken from the photograph, i.e. condition of roads; material of bridges, dams, computation are frequently bounded by undefined lines, wire fences, or something which will not show on the photo, and, besides, irregularity of the ground will cause a discrepancy between the picture area and the plane of the survey on the ground.

As far as (6) is concerned the air photograph merely gives a distorted view of *some* of the detail, unclassified and requiring inspection on the ground to identify and write descriptions. The table of conventional signs which usually accompanies standard topographic maps will show that very little detailed information can be gleaned from a photograph: this cannot be conveniently done because areas for buildings; telegraph and telephone lines and offices; the presence of water in watercourses, depth and direction of flow; nature of woods; characteristics of land; and a great deal of valuable information is lost in the shadows and vagueness of the photograph. A liberal allowance, therefore, for (6) would be one-half, which, added to the five-sixths already discounted, leaves approximately 8 per cent of the information required as possible by the aero-photograph method.

A distinguished U. S. professor of civil engineering writing upon aerial photos for mapping expresses the opinion that "under most conditions I am ready to argue that the results are in the class with mere sketches and that the claims of the promoters of work of this character ought to be discounted about 95 per cent." My estimate of aerial photographs being deficient in topographic information by about 92 per cent agrees very closely with this.

Winnipeg, Canada, Feb. 16. P. J. BARRY, Dominion Water Power Branch.

Sir—P. J. Barry is correct in his statement that the writer of the article entitled "Uses of Aerial Photographs in Map-Making," (*Engineering News-Record*, Feb. 2, p. 194) should have explained that "the methods referred to were merely those which came under his own personal observation."

This personal observation, however, extended over a period of seven or eight years, during which the writer has had direct supervision of the results obtained from the use of aerial photographs in connection with the field surveys executed by the A. E. F. in France and the aerial photographing of the complete coast line of the Dominican Republic and Haitian Republic, as well as about 5,000 sq. miles of the interior of those republics involving the taking of more than 20,000 photographs; he has also supervised or been in close touch with the aerial photographic mapping undertaken by the federal government in different parts of the United States.

The information obtained from these sources, together with 30 years' experience as a topographic engineer with the U. S. Geological Survey in topographic mapping, led the writer to make the deductions published in *Engineering News-Record*. In answer to Mr. Barry's question in paragraph 2, attention is called to the writer's statement that "the use of air photographs in connection with the general mapping of the country is confined at present to maps not larger than 1:10,000, and wherever photographs are used in connection with engineering problems they are for the purpose of facilitating the study of those problems as a whole, and only in exceptional cases can they be used for working plans."

The "frequent references" to the use of photographs in connection with the 1 in. to 1 mile map are explained by the fact that the standard scale for the general mapping of the United States is 1:62,500, or approximately 1 in. to 1 mile, and it is maps of this scale which will eventually receive the greatest benefits from the use of aerial photographs.

The use of aerial photographs for procuring other data than those which are usually obtained by plane-table methods, such as traverse or roads, watercourses, outlines of timbered areas and fence lines, has been given serious study and consideration, but the results of this investigation have shown that the methods employed in aerial photography have not yet been developed to the point where the photographs can supplant the ground surveys except as above mentioned, and the additional topographic data required to complete the map will have to be obtained by ground methods notwithstanding the fact that aerial photographs have been used.

The photographic method furnishes all the horizontal data usually obtained with the plane-table and in addition numerous data which have been found of sufficient value in the contouring of the area to enable the topographic engineer to complete the map in less time than would have been possible without the aid of the photographs, thus reducing the total cost of the completed map from 15 to 30 per cent, according to the character of the country under survey.

It is apparent that Mr. Barry has not had an opportunity to use aerial photographs in connection with the topographic mapping of large areas and his criticisms are, no doubt, due to the fact that he has in mind the use of aerial photographs in connection with surveys of small areas where a large scale is employed, such as 100 or 200 ft. to 1 in. It may be of interest to Mr. Barry to know that the committee on photographic surveying of the Board of Surveys and Maps of the federal government has published a report entitled "The Use of Aerial Photographs in Topographic Mapping," which goes into considerable detail. This report can be obtained from the Chief of the Air Service, War Department, Washington, D.C. GLENN S. SMITH, Acting Chief Topographic Engineer, U. S. Geological Survey.

Washington, D. C., April 8.

Comparison of Designs for Wabash Bascule Bridge

Sir—Referring to the article in your issue of Mar. 2, p. 363, describing the bascule bridge recently completed for the Wabash Ry. across the Rouge River at Detroit, I note the statement to the effect that this design is considered more economical than others and that it was selected after consideration of four other types of movable bridge, one of these types being a Strauss bascule.

This would lead your readers to believe that the Strauss type was proposed for this crossing among others, and that the design selected was given preference because of greater economy. This, however, is not the case. The Strauss company did not submit a design for this crossing and in fact did not know that the matter was up for consideration until long afer the order had been placed with the American Bridge Co. and the plans begun. The Strauss company was not requested to make any estimates of quantities or cost and furnished no such estimates, and it is self-evident therefore that the article was in error and that the Strauss design was not considered in the sense of a cost comparison to determine which type was the most economical.

The design selected is very interesting and is a compliment to the excellence of the heel-trunnion principle embodied in the Strauss patents, which patents seem to embrace the Wabash design, but we believe it only just to us and to the heel-trunnion type that it be clearly understood that a cost comparison between the Strauss heel trunnion and the Wabash bridge has not yet been made.

THE STRAUSS BASCULE BRIDGE CO., J. B. STRAUSS, President.

Chicago, March 17.

Teaching Descriptive Geometry

Sir—An interesting letter, "Teaching Descriptive Geometry," appeared in your issue of March 30, on p. 540. The *direct practical* value of the science is well brought out.

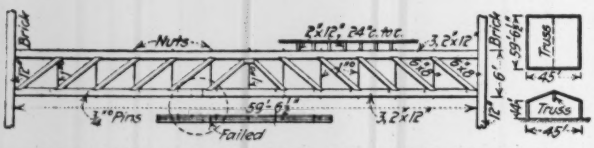
In this connection, a noteworthy point is the difference between the European and the American point-of-view. In Europe, specially in France, descriptive geometry is taught for its great value in developing the power of making clear mental pictures and in quickening the imagination. In our country, the *direct practical* use is stressed. In Europe, it is rather the *general educational* value that is stressed. There it is considered that sufficient justification for teaching descriptive geometry lies largely in the mental benefits of the study itself, a fact not generally known elsewhere.

J. A. DORST,
Major, Corps of Engineers, U. S. Army.

West Point, N. Y.,
April 22.

Defective Roof Truss in Service Five Years

Sir—I recently came across the truss pictured in the accompanying sketch and thought that some of your readers might like to figure as to what held it up for the five years that it was in service. As can be seen from the sketch, all the stress in the bottom chord was taken by the middle



TRUSS SAGGED 8 IN. AFTER BOTTOM CHORD BROKE

member and it had been reduced one half in section by the hole for the 1-in. rod. Failure finally occurred at this point, but instead of collapsing as might have been expected the truss sagged about 8 in. and showed no other signs of failure while being propped and braced.

Baltimore,
April 22.

AUGUST MENCKEN.

Early Report on the Hydraulic Jump

Sir—In some recent articles in the professional journals the impression is conveyed that the principles governing the application of the hydraulic jump as a means of absorbing high velocities in water were first developed and applied in the structures of the Miami Conservancy districts, subsequent to 1916. As a matter of history, in June, 1914, I submitted to the Knoxville Power Co. a report entitled "Studies on the absorption of kinetic energy and action of water at the toe of models of Cheoah Dam," giving the results of six months' experimental work on the subject, all of which resulted in definite and clear-cut conclusions. These conclusions were summarized in the exact words of that report as follows:

"Practically all of the kinetic energy of water flowing at high velocities in open channels may be internally absorbed by directing the water into pools of water exceeding a certain minimum depth and a certain minimum length.

"The theoretical minimum depth of the pool is given by the equation

$$2\sqrt{\frac{d_1 V_1^2}{2g}}$$

In which d_1 is the depth of the water before entering the pool and V_1 is the velocity of the water at the same point. This equation gives the depth of the pool above the same horizontal datum above which d_1 is measured.

"The required length of the pool is at least approximately equal to the net velocity head absorbed by expansion divided by 1.35. This gives the distance in which the bottom velocity is completely absorbed. About 20 per cent should be added to allow for complete absorption of velocities above the bottom.

"The depths and lengths of the pool must be uniform. Wherever V_1 is greater than the value used in computing the depth of the pool or the actual depth of the pool is less than the computed value, the probabilities are that the velocity will not be completely absorbed, and more or less agitation will ensue.

"The pool must be of the same width as the channel in which the water is flowing at high velocity and must continue at this width until the velocity is completely absorbed. Increasing the width of the pool beyond the channel width does not gain anything.

"In a channel of uniform cross-sections, such a pool may be formed by placing an obstruction at a sufficient distance down stream to permit of securing the required pool length. The dimensions of this obstruction must be such that the minimum depth required may be obtained.

"In high dams, subject to high velocities at the toe, complete absorption of the high velocities within the shortest distance possible, is desirable to prevent channel erosion and turbulent conditions in tail races, as much as possible.

"An efficient method of absorption is by directing the water into pools having the minimum depth given in preceding paragraphs.

"The height of the lip of the bucket above the bottom of the pool has little effect on the general efficiency of the absorption, if the lip is kept within the lower half of the pool's depth. The bucket with the lowest possible lip will allow the least wear on the concrete but as this is negligible on a well designed and constructed dam, the advantages of the highest possible bucket in decreasing the height through which the water falls and also allowing the use of longer buckets with less excavation and less concrete, may be considered paramount. The highest possible position of the lip with present knowledge is perhaps about half the depth of the pool.

"The required depth of pool varies as the depth on the crest, hence the longer the crest, the shallower the pool but also the bucket must be made longer.

"In no case must the product of the depth and the square of the velocity for any part of the water entering the pool exceed the value of this quantity used in computing the capacity of the pool.

"For the same head on the crest, arched dams by increasing the value of d_1 for the same discharge, require greater depths than do straight dams.

"Where pools of sufficient depth are not provided, it is probable that the entire kinetic energy of the water will be expended upon the channel and erosion will continue at a rapid rate until a pool of sufficient depth is excavated by the water."

These principles were recognized and used in the design of a number of overfall dams over 200 ft. high, two of which—the Narrows Development on Yadkin River and Cheoah Development on Little Tennessee River—were placed in operation in 1917 and 1919 respectively.

I am sure that the idea of the stilling basin has been long used by hydraulicians on the basis that the best way to stop a runaway horse is to head him into a haystack, and I believe that engineers in England and India recognized the jump as occurring at the toe of many completed dams, although its significance in the absorption of the high overfall velocities does not appear to have been appreciated. On the other hand I know of a long concrete wasteway on the Strawberry Valley Irrigation Project of the Reclamation Service, built many years ago with a total drop of about 90 ft., in which the designing engineer skillfully introduced one stilling basin half way down the slope and at the bottom put in another and turned the water abruptly exactly 90 deg. The sides of this basin were not over six feet high but no water left the basin except at the proper outlet and the high velocities at the entrance were completely stilled. I doubt if he understood theoretically what he was doing, but the device worked, or, as the article that started this discussion states, "the hydraulic jump is a success."

ROBERT F. EWALD.

Pittsburgh, Pa., March 9.

NEWS OF THE WEEK

New York, May 4, 1922

Fort Worth Flood Highest on Record

City Engineer Reports a Stage 2 Ft. Higher Than 1908 Resulting from 10.6 in. Rain in Two Days

A flood stage of 39 ft. on the government gage was reached in the Trinity River at Fort Worth, Texas, in the highwater beginning April 25. This is 2 ft. higher than the stage reached in the 1908 flood, the highest previous high water. City services were interrupted and great destruction was done in the lowlands, resulting from failure of the levee system above the city, according to D. L. Lewis, city engineer.

Fort Worth is located on the Trinity River and on the Clear Fork of the Trinity, the two streams joining near the center of the city. The business and main residential districts are on high ground, above flood stage. All damage was done in the lowlands, where there is a considerable dwelling-house district, factories, the city water pumping and filtration plants, and the plant of the Fort Worth Power & Light Co. The lowlands in and adjacent to the city are protected by a levee system on both rivers, but owing to the rapid rise of Clear Fork on the morning of the twenty-fifth a crevasse occurred at the upper end of the levee system and the flood waters flowed straight through the lowlands, producing a number of additional levee breaks which destroyed the effectiveness of the system.

Excessive Rainfall

Rain began falling about 11 p.m. on the twenty-fourth, and in six hours, by 5 a.m. of the twenty-fifth, a total of 7.54 in. had fallen. At 9:30 p.m. rain began again, and by 7 a.m. of the twenty-sixth another 3.06 in. had fallen. The cloudburst of the night of the twenty-fourth, apparently most intense over the upper drainage area of Clear Fork, produced a rise of 5 ft. per hour, in which the levee system failed. The city pumping plant and filter plant were flooded 3 ft. above the main floor, and both plants were shut down at 7 a.m. on the twenty-fifth. This deprived about three-quarters of the city of water supply. At 10 a.m. of the following day the water had gone down to 14 in. below the fire boxes and pumping again started, but another rise occurred from the rains of the night of the twenty-fifth-twenty-sixth, and the pump had to be shut down again at 11:30 a.m., for another 3-hr. period. The pumping plant was equipped with oil and natural-gas burners; oil was used regularly, but as the fuel oil-storage tank was washed away the resumption of pumping depended on one unit equipped with gas burners. On the following day, 8 a.m. of the twenty-seventh, the filter plant also resumed operation; all the filter beds had been flooded.

The electric plant of the Fort Worth Power & Light Co., at the junction of the rivers, was also shut down. Current supply, however, was maintained by the high-tension line connected with the Waco plant, 100 miles way, except during the early hours of the twenty-sixth, when an electric storm interrupted transmission service. This storm also paralyzed the telephone system.

Mr. Lewis estimates that 5,000 people were driven from their homes. The loss of life is now estimated at 35. Many persons were injured, and a great many families lost all they had. Much damage in the way of washouts was done to the steam and electric railways; nearly all lines were tied up.

By good fortune, only one fire occurred while the city was without water. This was extinguished by pumping water from a storage tank at a nearby ice plant.

Tree Wrecks Steel Bridge

A steel truss bridge over Sugar Creek near Washington Court House, Ohio, was wrecked on March 30 by a large tree falling on one of the trusses. The bridge was a county structure. The state in co-operation with the county is replacing it with a pony truss bridge of 104-ft. span and new abutments and slightly revised alignment to eliminate danger of curves at the approaches.

Mississippi Flood Stationary

Main levees are holding along the Mississippi, which continues to be in flood. Three breaks in river levees have flooded large areas; one at Ferriday, La., on the west bank a few miles above Natchez, one on the east bank 12 miles below New Orleans at Poydras and one on the west bank at Myrtle Grove, 35 miles below New Orleans. The upper break flooded by far the greatest area of the three but the flow will for the most part reach the river again below the Old River entrance. The lower two breaks will probably serve to reduce the maximum height at New Orleans.

Portland Cement Specification Made Standard

According to recent action of the American Engineering Standards Committee, the A.S.T.M. specification for portland cement has been advanced from the rank of tentative to the rank of "American Standard." The form in which it was thus approved is the form as revised in 1921 by compromise between the American Society for Testing Materials and the government interdepartmental committee. Other recent action of the American Engineering Standards Committee includes approval as tentative of the A.S.T.M. specifications for drain tile.

All-Embracing Construction Council Planned

Tentative By-Laws Drawn for Body Giving Equal Representative to All Interests

Representatives of all elements of the construction industry except labor and the construction departments of public utilities met in Cleveland April 28 and 29 and drafted a set of by-laws under which it is intended to form a federation or conference board representative of the entire construction industry and "dedicated to the improvement of the service which the construction industry renders to communities, states and nation." The name proposed for the organization is the American Construction Council.

Origin of Plan

Last week's meeting is an outgrowth of an informal discussion held in Chicago last month while the National Federation of Construction Industries was in session. During this discussion there was expressed by many interests the feeling that an all-embracing and balanced conference organization was needed and that no existing body met the requirements. The better part of three days was consumed in the discussion, resulting in the crystallization of the broad lines along which the new body should be formed. A committee was delegated to draw up a set of tentative by-laws conforming with the prevailing views, to set a date for a subsequent meeting and to invite through the appropriate associations, the attendance of representatives of the ten major groups into which the industry had been divided.

The representatives as appointed met for discussion of the draft in Cleveland last week, revised it and will now, through a steering committee composed of the secretaries of the Federated American Engineering Societies, the American Institute of Architects, the Building Trades Department of the American Federation of Labor, the Associated General Contractors, the National Federation of Construction Industries, and the National Lumber Manufacturers Association, endeavor to secure the adherence of as many as possible of the 250 associations in the construction industry and their participation through authorized delegates in the organizing meeting, to be held some time after June 19. The place of that meeting has not been determined.

Plan of Council

As outlined in the tentative by-laws the industry would be divided into ten groups, each with equal voting power. From each group would be elected two members of the executive board, of which the president, vice-president, secretary and treasurer would be members. The main body would meet in annual

(Continued on p. 751)

Government Near End of Its Case in Cement Trial

Evidence in North American Co. Case Allowed—Government Accountant Proves Interesting Witness

Before the end of the present week it is expected that the government will close its side of the case in the criminal trial of cement manufacturers of the Eastern District before Federal Judge Knox in New York City. It will probably take at least three weeks for the defense to make its case and at present it is not expected that a verdict will be reached much before the end of May. One of the popular features of the defense will be the exhibition of moving pictures showing the history of cement manufacturing.

Outstanding in the past week's evidence-taking has been the allowance by the presiding judge of the introduction as evidence of the minutes of meetings of the North American Portland Cement Co., a company organized in 1907 and the stock of which was held by six prominent cement concerns. The company was organized for the purpose of controling the patent uses of a then new method of burning cement with powdered coal. The patent was issued to the Alpha Portland Cement Co. and the other companies in the North American Company—Atlas, Lehigh, Lawrence, American and Vulcanite—were allowed the use of the patent upon a yearly payment of $200,000 and a royalty in addition, based upon shipments. The company was dissolved by common consent about four years after its organization, when some Western superior judge decided that the patent, though valid, was not basic.

All this history is being gone into by the government with the idea in mind that some control of cement production and distribution can be imputed to the North American company, and that such collusion, if proven, will reflect upon the present defendants, indicating a like disposition to production restriction.

Mill Bases Found Uniform

One of the most interesting of the government witnesses so far called was examined May 1. He is Walter Lewis, an accountaint permanently attached to the Department of Justice. Mr. Lewis testified to the fact that within the past three years he examined 928 out of 5,000 contract prices, and found, by deducting the bag charges and the freight rates, that in 95 per cent of the cases the prices bid showed an exact uniformity as between mill bases of competing concerns.

During the week the government examined a number of purchasing agents of large New York City contractors who testified as to the uniformity of cement quotations, discount practices, bag charges and bag-refund allowances. All of these men examined testified on cross-examination that they preferred to handle their purchases from dealers in view of the lack of storage and warehouse space, particularly where large amounts of cement were to be needed for specific jobs. The government has tried to make a strong point out of the fact that cement could be purchased only through dealers. The ability of dealers to truck cement to the job, as it was needed, was said by these witnesses to be a decided advantage.

The government also introduced as documentary evidence the statistics indicating the yearly productions of each mill reporting to the National Association as well as shipments and stocks on hand for the years 1916-1920. Included in these statistics were shipments made by mills for other mills for the years 1918-1920, and the percentage of each of these items—production and shipments—to the production and shipments of each mill. In the introduction of such evidence the government sought to show that the percentage was the same from year to year and therefore there was a definite allocation of business. The evidence was introduced through James W. Allen, a government accountain who has not yet been cross examined.

Other documentary evidence introduced by the government was in the form of Interstate Commerce freight tariffs which were to be checked against the freight-rate books circulated among members of the Cement Manufacturers Protective Association. It was charged by the government that there was an arbitrary variation made in the freight rate books. Selecting 25 out of thousands of cases it was found that errors had crept into the government compilations as well, and that in important instancs there was a variation only of a fraction of a cent.

Seattle Contracts for 66-Inch Steel Water Conduit

The contract for furnishing and laying 16 miles of 66-in. water conduit from Swan Lake to the Volunteer Park reservoir (see *Engineering News-Record*, Feb. 16, p. 297) has been awarded to Grant, Smith & Co., Seattle, for $1,468,603. Riveted-steel pipe will be used. For part riveted-steel and part wood-stave pipe the same bidder offered to do the work for $1,523,231. The only other bid for the entire work was $1,890,735 for lock-bar steel pipe throughout from the Puget Sound Bridge & Dredging Co. There were six bids for material alone and three for pipe-laying only. A. H. Dimock is city engineer.

Educators Would Ask Industry To Help Define Basic Studies

Conclusions reached by the second public conference on commercial engineering held under the direction of the committee on commercial engineering of the U. S. Bureau of Education, at Pittsburgh, May 1 and 2, favored the introduction into engineering schools of instruction in the elements of commerce, and into schools of commerce, instruction in the elements of engineering. These elements should be determined, the conference believed, after co-operation with industry to determine its requirements. It was recommended also that study be directed toward vocational selection and guidance for engineering students.

The conference was under the general direction of Dr. G. L. Swiggett, chairman of the committee on commercial engineering of the U. S. Bureau of Education, and was attended by about 160 representative technical and commercial educators.

Building Officials Discuss Improved Practice

Urge Restriction of Supervision To Competent Persons—Chimney Ordinance Approved

The collapse of the Knickerbocker Theater at Washington, D. C., in January of this year, furnished the principal topic of discussion at the annual meeting of the Building Officials' Conference, held at Indianapolis, Ind., on April 25, 26 and 27. The cause of the collapse was explained and the responsibility for it was discussed (see *Engineering News-Record*, Mar. 30, 1922, p. 532), resulting in the emphatic reiteration of the view expressed at the Pittsburgh meeting, two years ago. "It is the sense of the Building Officials' Conference that, for the better protection of the public against unsafe and illegal building construction, suitable legislation should be enacted by which building operations shall be restricted to architects, engineers, builders, superintendents of construction or others who have by proper evidence shown their ability or capacity for undertaking such building operations and on whom individual responsibility for the safe prosecution of the work and a compliance with the laws relating to buildings can be placed."

Building-Code Enforcement

Much the same conclusion was reached in the discussion of "The Enforcement of Building Code Provisions," a paper read by J. R. Hesser, commissioner of inspection of Toledo. Putting out of business the violator of building requirements was considered as perhaps the most effective method, much the same as lawyers are disbarred from practice for illegal or improper actions.

A plea was made in the treatment of "Fire-Resistive Qualities of Frame Buildings Protected by Stucco and Plaster on Metal Lath" by Wharton Clay, of the Associated Metal Lath Manufacturers, for recognition of such construction as suitable within the fire limits of cities, on the ground that brick walls with window openings do not afford any greater protection against exposure hazards.

The committee appointed a year ago to consider the "Ideal" wall, (see *Engineering News-Record* of May 5, 1921, p. 775) reported and recommended favorable recognition in building codes of this form of wall, but the meeting refused to commit itself farther than to declare that such walls can be safely constructed.

Other topics dealt with at the meeting, included "The Actual Strength of Brickwork and Its Relation to Code Allowances," a paper in which the use of 4-in. brick partitions was proposed by the author, William Carver, architect of the Common Brick Manufacturers' Association; "Building Code Requirements for Concrete Units and Practical Means for Their Enforcement," a paper by A. J. R. Curtis, manager of the cement products bureau of the Portland Cement Association, who advocated the licensing of block manufacturers; "Approval of New Materials of Construction Not Provided for in Building Codes," a paper by Albert E. Kleinert, superintendent of buildings, borough of Brooklyn, New York City, which

(Continued on p. 751)

All-Embracing Construction Council Planned

(*Continued from p. 749*)

session and at other times at the call of the executive board. The latter would meet at least three times a year and would have as its functioning representative an executive secretary.

Two classes of membership are provided — association and sustaining. Sustaining members may be individuals, firms or corporations interested in the industry. Only association members, through their delegates, would have the right to vote, and for such voting would be assigned to the appropriate group. The dues for association members have been fixed at $100 per annum; for sustaining members, at $25.

Objects of the council, as set forth in the tentative by-laws, are as follows:

"1. To consider subjects affecting the general welfare of the construction industry and the service which it should render the public.

"2. To establish the standards and principles which should govern the construction industry.

"3. To provide a medium for co-operative action among the several groups in the construction industry."

These objects are expanded somewhat by the preamble, which is as follows: "With the desire to place the construction industry on a high plane of integrity and efficiency and to correlate the efforts toward betterment made by the existing organizations, all the component parts of the industry herewith join in the formation of American Construction Council, a conference association representative of the whole industry and dedicated to the improvement of the service which the construction industry renders to communities, states and nation."

Among the suggestions of work that might be undertaken by the council, though not included in the by-laws, are federal legislation, collection of statistics, study of seasonal employment, development of apprenticeship system in the building trades, ethics, building codes, co-operation with government departments, transportation, publicity, encouragement of local assemblages representative of the whole industry such as the New York Building Congress, elimination of waste, and co-operation with the United States Chamber of Commerce.

Groups

The following ten groups, all to have equal voting strength, are provided for in the tentative by-laws:

(1) Architects; (2) Engineers, (3) General Contractors; (4) Sub-contractors; (5) Construction labor; (6) Material and equipment manufacturers; (7) Material and equipment dealers; (8) Financial, bond, insurance and real estate organizations; (9) Public utility construction departments; (10) Representatives of federal, state, county and municipal bureaus and departments concerned with construction.

The following engineers and contractors attended the meeting last week: L. W. Wallace, Washington, and E. J. Mehren, New York, representing the Federated American Engineering Societies; W. A. Rogers, Chicago, Leonard C. Wason, Boston, N. F. Hoggson, New York and R. C. Marshall, Jr., representing the Associated General Contractors; C. M. Upham, Raleigh, N. C., representing the American Association of State Highway Officials; and P. St.J. Wilson, of the U. S. Bureau of Public Roads.

E. J. Russell, the well known St. Louis architect, acted as chairman of the meeting and W. S. Hays, of Philadelphia, was secretary.

Urge $75,000,000 Road Bond Issue in Georgia

The Georgia Good Roads Association, of Atlanta, is conducting a campaign in support of a proposed $75,000,000 bond issue for highway improvement. It is planned to raise this money without any additional property tax by retiring the bond issue, both as to interest and principal, by motor-vehicle license fees and a gasoline tax.

New Standard Mechanical Filter Specifications Adopted

At a recent meeting of the Associated Manufacturers of Water Purification Equipment standard specifications for pressure filters of the mechanical type were adopted. These include rates of filtration for water for various purposes; standard sizes of filters for various capacities, together with standard sizes of pipe connections, minimum rates of wash water; and figures to control the design of both steel and cast-iron filters under various working pressures. Copies of the specifications may be obtained from F. B. Leopold, secretary, Associated Manufacturers of Water Purifying Equipment, 618 Farmers' Bank Building, Pittsburgh, Pa.

Asphalt Association Convenes

The Asphalt Association, at its annual convention in New York, April 12 adopted a resolution embodying the views of its president, J. R. Draney, urging a minimum width of 24 ft. for highways serving large cities to afford more room for the increasing traffic. "I have ridden over more dangerous roads in the vicinity of New York," said Mr. Draney, "than one will find, for instance, in the whole of England."

Other resolutions adopted by the convention urged that President Harding take such steps as are necessary for the United States to become a member of the International Good Roads Congress; demanded a reduction in freight rates on asphalt and other road-building materials so as further to reduce the cost of highway construction; and expressed vigorous opposition to a tariff on crude oil in view of the fact that 60 per cent of America's supply of asphalt is now obtained from Mexican petroleum and in view of the further fact that asphalt enters not only into 60 per cent of the roofing materials used in the United States but into practically every type of street and road paving.

"That American cities are making tremendous strides in street paving," continued Mr. Draney, "is indicated in reports from city engineers which show that over 30,000,000 sq.yd. of asphalt equivalent to 1,750 miles of pavement 30 ft. wide, were laid on city streets in 1921. About 23,000,000 sq. yd. were laid on state highways and the area laid on county and district roads brought the total for 1921 up to 68,000,000 sq.yd.

20-Mile Steel Conduit To Cost Over $4,000,000

Spring Valley Co. and San Francisco Agree on Additional Supply of 24 m.g.d. from Calaveras

Under an agreement recently made between the city of San Francisco and the Spring Valley Water Co. the company's water supply is to be augmented by 24 m.g.d. brought by conduit from the Calaveras water-shed to the company's reservoirs in San Mateo Co. The new line will be about 20 miles long and will consist of 5-ft. steel pipe except for about 8,500 ft. of tunnel and a half mile of submarine line across the lower part of San Francisco Bay. The 5-ft. pipe is larger than is required for the supply now to be brought in but is to be located on the Hetch Hetchy aqueduct right-of-way and is expected to carry 45 m.g.d. from Hetch Hetchy sources at a later date. The city expects to spend between $4,000,000 and $5,000,000 on the work which is to commence in June. To deliver Calaveras water to the Hetch Hetchy conduit grade line will require pumping against a head of about 220 ft. The city is to pay for and install the necessary pumping station and the company is to pay its operating costs.

To bring Calaveras water to the city's right-of-way the Spring Valley Co. will spend about $2,000,000 in increasing the height of the Calaveras dam, increasing the capacity of the Sunol aqueduct, and building about 20,000 ft. of new conduit from Irvington to the Niles screen tanks.

The arrangement between the city and the company provides that the city shall build nad pay for the 5-ft. pipe and all necessary structures on the Hetch Hetchy right-of-way and these only. The company is to have the use of the line in return for the payment of 5 per cent interest on the investment, which payment shall not exceed $250,000 per year. The company will pay interest during a construction period of not more than three years. Ordinary maintenance on the aqueduct is to be paid by the company, while extraordinary repairs will be made by the city. The agreement can be terminated by either party on three years' notice.

Santa Fe to Build Branch Line to Los Angeles Harbor

Plans are under way for the construction of a 12-mile railroad spur from the line of the Atchison, Topeka & Santa Fe Ry. Co. near El Segundo to Wilmington, Cal., where connections can be made with the Belt Line R.R. serving Los Angeles harbor and which is operated by the city of Los Angeles. No large terminals will be constructed at the harbor, according to officials of the Santa Fe Ry. because these facilities are largely under city control.

Arrangement has been made between the city and the railroad company, under which the construction will be handled by the Santa Fe and Los Angeles Harbor Ry. Co. which was incorporated for this purpose. The new line will not involve any heavy grading or difficult construction. A considerable portion of the right-of-way has yet to be secured and no construction will start until this has been done.

Kruttschnitt Attacks Federal Maintenance of Railroads

Testifying recently before the Senate Interstate Commerce Committee, now investigating the railroad situation, Julius Kruttschnitt, chairman of the board of the Southern Pacific Co., asserted that statistics compiled by the Interstate Commerce Commission show that during the period of federal control the director general of transportation skimped in the use of both ties and rails. "In two years," said Mr. Kruttschnitt, "cross-tie renewals were 32,628,360 short—enough to lay 11,500 miles of track. Rail renewals were cut 440,230 tons—enough to lay 3,120 miles. There was also a shortage of 1,816,155 cu.yd. of ballast used in repairs.

"Mr. McAdoo tries to convince himself that it was not his duty to put into the track an average number of ties annually, determined by the test-period average, in order to fulfill the obligations of the government to return the properties in substantially as good repair as they were on Jan. 1, 1918. If the federal administration had discovered a way to maintain a track for two years on a 28-per cent reduction annually from the number normally used, it had discovered something of inestimable value to maintenance engineers."

Citing the Louisiana and Texas lines of the Southern Pacific system specifically Mr. Kruttschnitt charged that tie replacement made during federal control in those lines was inadequate both in quantity and quality and that "hundreds of thousands of low-grade ties were used in violation of the President's promise and contract obligation."

"The damage to the railroad property," he said "is continuing until the inferior ties are removed, but as long as they remain in the tracks the maintenance expense is increased largely over what it should be under the company's specifications."

Trenton Also to Fight State Water-License Fee

The city of Trenton, N. J., has decided to appeal to the U. S. Supreme Court against the decision of the New Jersey courts, upholding the legality of the water tax or license on water diverted from streams of the state for municipal water supply in excess of diversions being made in 1907, when the diversions exceed 100 gal. per capita.

The State Department of Conservation and Development secured a judgment for $14,310 against Trenton. The New Jersey State Court of Errors and Appeals on March 6 sustained the judgment.

The board mentioned has also a judgment of $18,104 against Newark for the diversion of water, which also has been sustained by the highest court of New Jersey. It is now proposed that the two cities join in an appeal to the United States Supreme Court, alleging that Chapter 252 of the New Jersey laws of 1907 offends against Article 1, Section 10, of the Constitution of the United States, which limits the powers of individual states.

A note on the revenue received from the State Water License in New Jersey appeared in *Engineering News-Record*, April 27, p. 702.

Wisconsin Road Contracts Show Lower Prices Than Last Year

Comparing the contract prices of roads in Wisconsin up to April 1, 1922, with those of 1921, A. R. Hirst, state highway engineer, in his quarterly report to J. G. D. Mack, state chief engineer, states that the total cost is 26 per cent less this year. Last year surfacing 95.36 miles of road cost $2.77 per yard; grading 323,235 cu.yd. cost $1.17 per cubic yard; and clearing, grubbing, culverts and guard rails cost $1,000 per mile. This year's figures are $2.05 for paving, $0.81 for grading and $900 for clearing, grubbing, culverts and guard rails, making a mile of road cost $25.383, or $8.953 less than in 1921.

Estimated money available for 1922 construction and maintenance for state and county roads is $26,744,000, of which $4,587,000 is for maintenance.

American Science to Have Home in Washington

C. L. Walcott, president of the National Academy of Sciences, has announced that a large building to cost in the neighborhood of $1,300,000 is to be erected in Washington, D. C., to be used as a center for American science. The building will be the home of the National Academy of Sciences and the National Research Council. In it investigators from all parts of the country and abroad may be brought together for counsel and co-operation.

The building will face the Lincoln Memorial. It will have a frontage of 260 ft. The building is a gift of the Carnegie Corporation of New York City. The ground was bought at a cost of about $200,000 through private donations. The architect is Bertram Grosvenor Goodhue of New York City.

Citizens Committee of Engineers to Advise Town Officer

A citizens advisory committee of six engineers has been appointed by Dr. James T. Hanan, town commissioner of Montclair, N. J., in charge of the Department of Streets and Public Improvements. The chairman of the committee is M. N. Baker, associate editor, *Engineering News-Record*. Other members are: A. P. Folwell, editor *Public Works;* H. P. Hamlin, designing engineer, Raymond Concrete Pile Co.; Albert W. Hemphill, a utilities engineer; Malcolm McFarlane, a railway and coal engineer, and John J. Swan, of the Engineering Business Exchange.

Reconditioning Leviathan Begins

The steamship Leviathan contract for the reconditioning of which was recently awarded by the U. S. Shipping Board to the Newport News Shipbuilding and Drydock Co. docked at one of the piers of the latter's plant at Newport News, Va., April 10. Homer L. Ferguson, president of the company, states that work on the giant liner will start at once and that about 1,200 additional men will be employed at the plant during the period of reconstruction.

Neil Christianson will supervise the installation of and repairs to machinery; E. I. Cornbrooks will superintend the hull construction, and T. W. Ross will have charge of refitting.

Engineering College Holds Three-Day School for City Officials

The school of engineering of the University of Kansas, Lawrence, Kan., recently conducted a "Three-Day School" for mayors, city managers, commissioners, councilmen, city clerks, health officers, engineers, superintendents and operators, the latter referring particularly to operators of sewage and water treatment plants, for whom round-table discussions were held. There were a number of addresses on each of the topics—water purification and sewage treatment.

Other topics were municipal administration, city planning, municipal building codes, and financing municipal improvements. Among the "faculty" of 17 speakers were Prof. W. C. Hoad, University of Michigan; C. A. Haskins, R. E. McDonnell, W. Kiersted, and E. B. Black of Kansas City; Profs. P. F. Walker, C. C. Williams, W. C. McNown, and A. H. Jewell of the University of Kansas.

Seeks to Enjoin City Engineer from Taking Private Work

Unfair competition by the city engineering department of South Bend, Ind., with other professional engineers is charged in an injunction suit filed there recently to enjoin the city from engaging in private engineering work. When the case is tried, questions will be raised as to a city's authority to engage in private enterprise and the decision may establish a precedent applicable to all Indiana cities.

The suit was filed by Charles W. Cole, a civil engineer, against the City of South Bend, the city comptroller and Frederick Anderson, city engineer. Mr. Cole alleges that competition of the city officer with professional engineers is unfair because the prestige of the city is used and also that his fees are much below the regular engineering fees. Some cities in Indiana have specifically forbidden their city engineers to engage in private work.

Detroit Votes To Acquire Street Railway System

By a vote of 82 per cent of the ballots cast Detroit electors have indorsed the purchase by the city of the Detroit United Railway's city system. A 60-per cent favorable vote was required for a decision.

The city will take over the system on May 15, whereupon Detroit will have the largest municipally-owned street railway in the world, comprising 263 miles of track with 1,457 cars and all necessary equipment.

According to the plan of purchase a bond issue of $4,000,000 has been voted of which $2,770,000 will be paid down to the railway company when it turns over the property. The remainder will be required to purchase supplies and materials now in the company's hands and to provide working capital. Semi-annual payments of $500,000 will be made by the city until 1933, at which date the balance of the $19,850,000 purchase price will come due. Interest at the rate of 6 per cent will be paid on all the unpaid balance. The money will go to a trust company to the credit of mortgage and bond holders of the company.

Large Generator Bursts at Niagara Plant

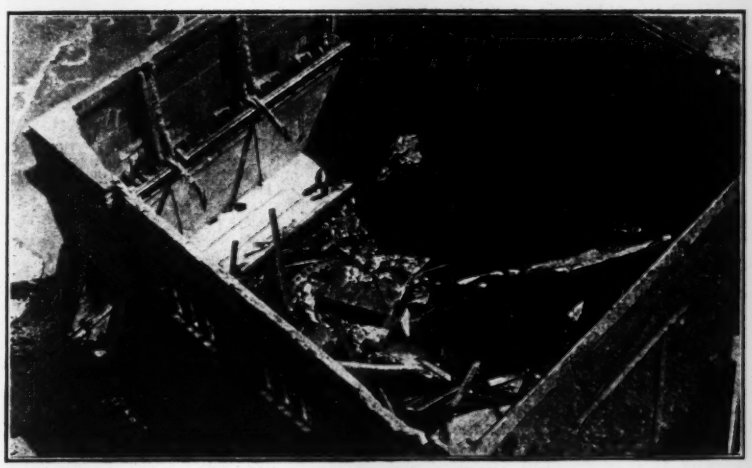
On April 20, about 3 a.m., the generator of a 20,000 hp. water-wheel unit in the plant of the Ontario Power Company, at Niagara Falls, Ont., burst, putting out of commission a neighboring unit of similar capacity and causing the shut-down, on account of flooding, of four 16,000 hp. units. Some of the flying pieces struck the roof trusses causing the failure of the roof and the consequent destruction of some of the auxiliary apparatus.

The unit which burst, No. 15, was one of two identical units installed during the war and was located in an extension of the original power house, forming a separate room for the two machines. Both units are horizontal shaft machines with two water-wheels each. The sequence of events is not entirely clear, though it is known from testimony of operators at the plant of the Canadian Niagara Falls Power Co., with which the Ontario lines were tied in, that their units began to speed up as a result of a short circuit, probably carrying the Ontario units with them. There was only one man in the room at the time and he is unable to explain satisfactorily what happened.

Apparently the wheels on both units in the extension are intact except for a hole in one of the casings of No. 15. A piece of the rotor of the burst machine passed through the roof over the main part of the plant and down again through the roof, landing about 150 ft. from the center line of the destroyed machine. Fortunately it struck merely the base of one of the other units without doing any other damage than the punching of an additional hole through the roof. The flooding was due to the hole in the casing of No. 15.

A thorough investigation of the accident is now being made by the engineers of the Ontario Hydroelectric Power Commission, which owns and operates the plant, and the results will be published shortly.

The water-wheels were built by the S. Morgan Smith Co., and were purchased from the plant of the Aluminum Company of America at Baden, N. C. The generators were built by the Canadian-General Electric Company.



LOOKING FROM CLIFF TOP INTO WRECKED POWER HOUSE OF ONTARIO POWER CO. AT NIAGARA

New England Water-Works Men To Meet at New Bedford

The New England Water Works Association will hold its 1922 annual convention at New Bedford, Mass., Sept. 12-15. Frank J. Gifford, Tremont Temple, Boston, Mass., is secretary of the association.

Chapter Activities Feature of A. A. E. Annual Meeting

At the Salt Lake meeting of the American Association of Engineers, June 5, 6 and 7, a symposium on chapter activities will be one of the outstanding features. It will include the following subjects: Principles of chapter success; a standard chapter constitution; how to rate your chapter; local civic responsibility and co-operation with other civic bodies; chapter bulletins and news letters; how to do chapter work; obtaining and holding members; publicity and public affairs; conducting chapter meetings; selection of chapter officers; how to make officers function; how to arouse and sustain the membership interest; how to assist national headquarters in collecting dues and the sphere of women in chapter activities.

Of the internal problems to come up probably the most vital one refers to the foundation of departments within the organization to look out for the branches which represent any considerable portion of the membership. A plan for a greatly-extended employment service bureau has been under consideration by the board of directors and will come up for adoption. K. H. Talbot, chairman of the employment service committee has recommended that there be set aside for this purpose $1 of the national dues independent of any division between chapter and national activities.

No Reorganization in Tennessee Highway Department

An error was made in the news item which appeared in the April 20 issue of this journal, p. 669, stating that a bill reorganizing the Tennessee Highway Department had been approved by the Governor. No reorganization has been authorized.

Senate Passes Relief Bill for Naval Contractors

After months of effort the Senate passed on April 22 the bill providing for the relief of naval contractors, subcontractors and material men who suffered losses as a result of the interference by the Government with the performance of their contracts. Most of the claimants who will profit by the bill are small contractors.

In the great majority of the cases there is no question as to the responsibility of the Government. The losses were occasioned during the war by the action of Government agencies in commandeering materials, or by reason of the inability of contractors to secure materials due to the priority policy in the matter of transportation.

Outdoor Exhibition of Sculpture in Central Park Abandoned

The National Sculpture Society has withdrawn its application for a permit to use a portion of Central Park, New York City, for an exhibit of outdoor sculptural work. The application was strongly opposed by the New York Parks and Playgrounds Association, the New York Chapter of the Society Landscape Architects, and other organizations. Editorial comment on the proposal appeared in *Engineering News-Record*, April 20, p. 636.

$4,000,000 for Narrows Tunnel

An appropriation of $4,000,000 for preliminary work on the Narrows tunnel between Brooklyn and Staten Island, was voted by the committee of the whole of the New York Board of Estimate and Apportionment May 1.

Tri-State Water and Light Men Enlarge Field

At the twelfth annual convention of the Tri-State Water & Light Association of the Carolinas and Georgia, held at Spartanburg, S. C., April 18-20, it was decided to enlarge the geographical field of the association to include Florida, Alabama, and Tennessee. Action on a new name for the association was deferred until the next meeting.

The new president of the association is J. E. Gibson, superintendent and engineer of water-works, Charleston, S. C. W. F. Stieglitz, Columbia, S. C., was re-elected as secretary and treasurer. The next meeting place will be selected later.

Among those discussing the various topics presented were E. L. Filby, sanitary engineer, South Carolina State Board of Health; H. F. Lee, manager, Carolina Power & Light Co., Goldsboro, N. C.; and Wilder M. Rich, city manager of Goldsboro. There was an exhibit of water-works appliances.

Slate Producers Organize

Organization of slate producers in the United States into the National Slate Association was effected at the Hotel Commodore, New York City, April 20. The purpose of the organization is to promote uses of slate products and to disseminate generally information regarding such products. The organization was due largely to the efforts of Oliver Bowles of the U. S. Bureau of Mines.

The following executive committee was appointed to formulate a detailed organization: Wm. H. Keenan, Bangor, Pa., chairman; G. H. Shinville, Fairhaven, Vt.; N. M. Male, Pen Argyl, Pa.; Roscoe C. Berlin, Slatington, Pa.; F. C. Sheldon, Granville, N. Y.; E. R. Norton, Granville, N. Y.; G. F. Barnard, Boston, Mass.; A. H. Morrow, Pawlet, Vt., treasurer; and W. S. Hays, Philadelphia, Pa., secretary.

Abolish Board of Consultants on Vehicle Tunnel

By resolution of the New York and New Jersey tunnel commissions May 2 the board of consulting engineers has been abolished, but on the recommendation of C. M. Holland, chief engineer, the members of the board have been reappointed individually as consultants to be employed subject to the recommendation of the chief engineer on a basis of $150 a day. The consulting board, members of which formerly received salaries of $10,000 each, consisted of Col. William J. Wilgus, chairman; J. Vipond Davies, John A. Bensel, William H. Burr, Col. George L. Watson and Edward A. Byrne. Mr. Byrne served without compensation; he is chief engineer of the Department of Plant and Structures of New York City.

House Passes Federal-Aid Bill

(Washington Correspondence)

The federal-aid highway bill, recently agreed upon by the Committee on Roads of the House of Representatives, passed the House this week, with no amendments, by a vote of 239 to 31. The bill appropriates $65,000,000 for federal aid for the fiscal year ended June 30, 1923, and $75,000,000 for the fiscal year ended June 30, 1924. In addition the bill carries $6,500,000 for forest roads.

Francis Made Engineer to Board Investigating Chippawa Project

Walter J. Francis, of Montreal, has been appointed engineer to the Royal Commission (see *Engineering News-Record*, April 20, p. 669) recently created to investigate the Queenston-Chippawa power-development scheme of the Hydro-Electric Power Commission of Ontario. Two of the five members of the commission are engineers.

Building Officials Discuss Improved Practice

(Continued from p. 750)

brought out the suggestion that municipalities should join in the cost of having new materials investigated at laboratories of recognized standing through committees of their building officials; and "Fire Tests of Loaded Timber Columns" in which Theodore P. Laist, of the National Lumber Manufacturers' Association, called attention to the possibility of more than doubling the fire endurance of Southern pine or Douglas fir columns by adequate protection against fire of the ends of such columns.

Endorsement was given to the chimney ordinance recently recommended by the National Board of Fire Underwriters as worthy of favorable consideration in the preparation of building codes, and all similar "efforts to increase through the advocacy of good construction, the safety of the public against fire hazards" were commended.

At a joint session with the Indiana Limestone Quarrymen's Association it was contended that the requirements in most of the present building codes relating to use of stone, especially as ashlar, are antiquated and have not been changed to meet the new conditions prevailing in present-day construction. New Provisions were urged. A committee was appointed for their study. After the meeting, the members and delegates visited the limestone quarries and mills at Bloomington and Bedford, Ind., as guests of the association.

Reports were received from representatives of the Building Officials' Conference on the Building Code Committee of the Department of Commerce, and on the sectional committees of the American Engineering Standards Committee, on floor openings, railings and toe-boards, on building exits, on elevators, and on construction work.

The following officers were elected for the coming year: Rudolph P. Miller, New York, president; James G. Houghton, Minneapolis,, vice-president; Fred W. Lumis, Springfield, (Mass.), secretary. The executive committee for the coming year will consist of these officers and Walter R. Forbush, Newton (Mass.); Matt. S. Shinnick, Kansas City; Frank Burton, Detroit; and H. E. Plummer, Portland, (Ore.).

McConnell Returns from Brazil

Ira W. McConnell, vice-president of Dwight P. Robinson & Co., engineers and constructors, New York City, who has been in Brazil since last September in active charge of the irrigation work under construction for the Brazilian Government by his company in the states of Ceara and Parahyba, returned to New York April 30. During the past few months Mr. McConnell has been in Rio de Janeiro giving general supervision to the beginning of the work on the Embassy building, being constructed for the United States Government in connection with the Rio Centennial Exposition. Mr. McConnell will probably be in New York several months before returning to Brazil.

Cargo Handling Discussed

Economical handling and storage of cargoes at marine terminals was the subject of a meeting held by the American Society of Mechanical Engineers, in New York, on April 28. Dr. R. S. MacElwee, of Georgetown University, presented a paper on "Location of Warehouses with Relation to the Handling of Material," and Francis Lee Stuart, consulting engineer, discussed the "Rehabilitation of Old Piers to Reduce the Cost of Handling." John Meigs, consulting engineer of Philadelphia, discussed both of the papers.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 9-11.

NATIONAL HIGHWAY TRAFFIC ASSOCIATION, New York City; Annual Meeting, New York City, May 12.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Philadelphia, May 15-19.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, Salt Lake City, Utah, June 5-7.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Annual Convention, Portsmouth, N. H., June 21-22.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Convention, University of Illinois, June 20-23.

The New York Section, Am. Soc. C.E., will discuss the need of regional planning for the New York District at its regular monthly meeting, May 17, 1922. Charles D. Norton, first chairman of the plan of Chicago will open the discussion.

The Boston Society of Civil Engineers has elected the following officers: President, Dugald C. Jackson; vice-president, Charles M. Allen; secretary, John B. Babcock, 3rd; treasurer, Frank O. Whitney.

The Richmond Chapter, A. A. E., has elected the following officers: President, J. C. Carpenter; vice-president,

E. T. D. Myers, Jr.; secretary, Albert C. Dunn; treasurer, E. E. Davis.

PERSONAL NOTES

JOHN S. DOYLE, principal assistant to the United States Engineer in charge of the Baltimore harbor, has been appointed a major to command the second battalion of the Three-Hundred and Forty-Third Regiment of Organized Reserve Engineers, the headquarters of which are in Baltimore. The appointment was made by Lieut.-Col. R. Keith Compton, of the regiment, who is chairman of the Paving Commission.

FRANK H. CLARK, formerly superintendent of motive power of the Baltimore & Ohio R.R., who has for the past two and a half years been technical advisor to the Ministry of Communications of the Republic of China, engaged in motive power and equipment standardization work at Peking is now visiting in the United States and is at present in New York.

H. E. BECKMAN has resigned his position of assistant engineer in charge of the southern district engineer's office of the C. M. & St. P. Ry. at Chicago to enter the roofing contracting business as secretary and treasurer of the Interstate Roofing & Supply Co. of Cicero, Ill.

S. H. LEA, County Engineer of Mineral County, W.Va., has resigned to accept appointment as district engineer in charge of road construction for Cacapon District, Morgan County, W. Va.

W. H. NORCKAUER has been appointed office engineer of the State Highway Commission, Maison Blanche Annex, New Orleans, succeeding W. F. Cooper, who was recently made a member of the newly created State Highway Commission. Mr. Norckauer was graduated from the Louisiana State University in 1909, and immediately became identified with highway work in Louisiana, under the Federal government. When the state highway department was created in 1911, Mr. Norckauer was retained by the state authorities, first as field, then as district, and more recently as assistant office engineer under Mr. Cooper, whom he now succeeds.

W. H. DAVIS, formerly resident engineer, West Virginia State Road Commission, with headquarters at Martinsburg, W. Va., was appointed February 1, 1922, maintenance engineer, West Virginia State Road Commission, with headquarters at Clarksburg, W. Va.

R. E. STOELTING, until recently city planning engineer, Milwaukee, Wis., has been appointed commissioner of public works.

ALEXANDER W. GRAHAM, chief engineer of the Missouri State Highway Commission has resigned, effective May 1. C. W. Brown, his assistant, becomes acting chief until election.

C. W. MURRAY, for many years city engineer of Tampa, Fla., was given the title of director of public works and public welfare with an increase in salary when the city commission took office several months ago and will have charge of preparing plans for the city's $400,000 harbor development.

LEONARD A. BERGMAN has been appointed city engineer, Jamestown, N.Y.

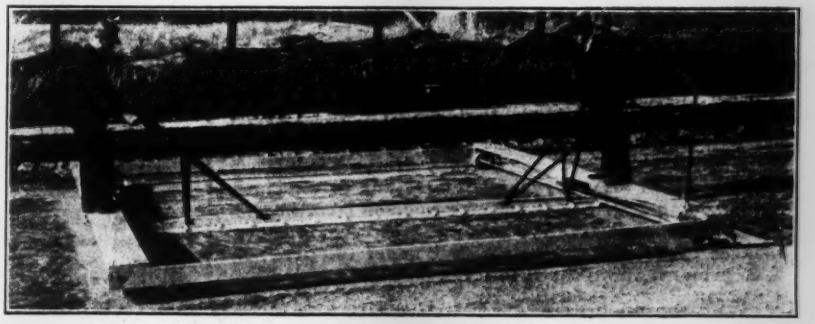
BUSINESS NOTES

THE LAKEWOOD ENGINEERING CO., Cleveland, Ohio, announces that the CONTRACTORS TRADING CO., INC., New York, will handle their building construction equipment exclusively. Geo. H. Edbrooke, formerly with the Lakewood Engineering Co. is sales manager, and Lloyd Wilson of the Lakewood Engineering Co. is associated with them as factory representative.

OBITUARY

MORRIS A. TALBOT, member of the engineering firm of M. A. Talbot Co., Rome, N. Y., died recently in Seattle, Wash.

HENRY BUTLER HUGHES, who had been connected with the Philadelphia Department of Public Works, specializing in tunnel and filtration work, died in New York City, April 16. During the World War he was appointed senior structural engineer with the construction division of the army. Later he was appointed engineer of the Bureau of Mines, which position he held until 1920 when he became connected with some of the municipal work in New York City.



EQUIPMENT AND MATERIALS

Full Diesel Engine for Shovel, Dragline or Crane

An oil shovel which will use any cheap low-grade fuel oil of high heat-value has been developed by the Bucyrus Co., South Milwaukee, Wis. The engine is of the full Diesel type with mechanical injection under constant pressure and develops 55 hp. at a speed of 360 r.p.m. The cylinders are 8 x 10½ in. The fuel is burned in the cylinders without the aid of a carburetor, spark plug or outside heating appliances, the charge being fired by the heat developed by the compression of air in the cylinders on the previous stroke.

On test under winter conditions it is stated the engine consumed 1⅞ to 2¼ gal. of fuel oil per hour. The engine was designed to handle the recently-developed type of gasoline shovel which operates the thrust without the use of an independent engine mounted on the boom.

Longitudinal Floatbridge for Concrete Pavement

A hand-operated floatbridge facilitating the use of the longitudinal float, to eliminate waves and to increase the riding qualities of a concrete road, has recently been put on the market in California by Edward G. Carr. It consists of a rectangular frame of 2 x 12-in. trussed cross planks and 2 x 6-in. sides mounted on 8-in. wheels riding the side forms. A finishing belt is attached to the frame to rub out the marks left by the longitudinal float. The belt is moved back and forth in 10-in. strokes by the upright lever shown at the right. The lever operates a ratchet wheel on the rear axle, propelling the floatbridge forward 2 in. per stroke. The bridge is moved ahead about 10 ft. at a time, thus giving a 6-ft. lap of the longitudinal float, which is a light 16-ft. straight edge with plow handles and a 10-in. float board. The edge of the float is not used to strike off the concrete, but its whole bottom surface is used to work down the high places.

Operation of the longitudinal float for best results is a deliberate pull back and forth with a 6-to 18-in. stroke. Fast operation is not desirable, as the float then slips over the surface of the concrete without disturbing more than a thin layer at the top, whereas the suction attending a slow movement pulls and readjusts the concrete to a greater depth. To accentuate the suction the ¾ x 10-in. float board is made of a fine-grained soft wood soaked in paraffin. The soft wood wears even and smooth, but does not polish. The paraffin keeps out all the excess moisture.

Out-of-the-Ordinary Trade Publications

Illustrated booklets on the different types of asphalt pavement construction including sheet asphalt, asphaltic concrete, asphalt macadam, asphalt filler, asphalt to resurface worn brick, and asphaltic road oil, have been prepared by the TEXAS CO., New York. "What is Your Highway Problem" is the name of a portfolio issue by this concern which gives a résumé of each type of highway construction in which asphalt is used.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Contracts for Four Months Worth $479,000,000

Of This $143,000,000 is Total for April —$100,000,000 in Street and Road Work Put Under Contract

Since Jan. 1, 1922, up to and including April 25 there were put under contract throughout the United States construction jobs the total value of which approximates $479,000,000. Of this amount $143,000,000 in round numbers is the record for April. This total compares with $688,000,000 worth of work contracted for during January, February, March and April, 1920, and $332,000,000 in 1921.

One of the notable features in an examination of the contract-value figures is the fact that during the past four months approximately $100,000,000 worth of street and road work has been put under contract. In actual dollars this represents an increase over the corresponding period of 1920 and 1921 of 13 and 28 per cent, respectively. According to the rate at which street and road work is being contracted for at the present time, there will probably be put under contract during the year approximately $350,000,000 worth of work.

During April of 1922 considerable activity was noted in the number and value of railroad contracts let. In the tabulations herewith railroad work is included under the general classification of "Miscellaneous." Though *Engineering News-Record* in its Construction News lists railways under a separate classification there was practically no railroad work done during 1920 or 1921, which fact accounts for the absence of the railway classification from the tables herewith.

Another feature revealed in examining the contracts let for April of 1922 is the fact that in public-works construction, though the total value is not remarkably high, there is indicated quite a widespread activity because of the number of small contracts being let.

The total value of contracts let in April, 1922, represents in the volume of construction done at least 75 per cent more work than was done in April, 1921. In actual dollars the April, 1922, figure exceeded the 1921 figure by $37,000,000, though the April figure fell short of the March, 1922, figure by about $50,000,000.

In the geographic distribution of contracts let for the month of February, the heaviest percentage was reported from the Middle Atlantic, about 30 per cent of the work for the month being contracted for in that district. The high figures for the Middle Atlantic and Middle West are due to the large amount of work which is under way in New York, Philadelphia, Boston, and Chicago.

During March, as is indicated by Table 2, 43 per cent of the work contracted for for the month was in the Middle Atlantic states. The other geographical sub-divisions reported the following percentages of the total: Middle West, 19 per cent; Western, 14 per cent; Southern, 11 per cent; West of Mississippi, 9 per cent, and New England States, 4 per cent. The percentage, however, for the Middle Atlantic, as well as the total figures for March, were considerably affected by one $20,000,000 contract.

For any month the value of contracts let as reported in *Engineering News-Record* does not include any residential building except the construction of apartment houses. Experience has shown that residential building for any month usually equals the total contract value as reported in *Engineering News-Record*. This would indicate that the total value of contracts let throughout the United States during the month of March was in the neighborhood of

VALUE OF CONTRACTS LET IN THE UNITED STATES IN MARCH, 1922

	New England	Middle Atlantic	Southern	Middle West	West of Mississippi	Western	Total
Waterworks	$15,000	$456,000	$91,000	$173,000	$349,000	$9,000	$1,093,000
Sewers	32,000	942,000	372,000	1,660,000	583,000	207,000	3,796,000
Bridges	45,000	36,000	656,000	85,000	233,000	82,000	1,137,000
Excavation and dredging	68,000	.....	151,000	100,000	240,000	10,000	569,000
Streets and Roads	721,000	7,574,000	13,315,000	6,094,000	4,705,000	7,260,000	39,669,000
Indus. works	2,500,000	6,077,000	680,000	3,238,000	1,620,000	2,288,000	16,403,000
Buildings	4,806,000	34,821,000	3,026,000	21,387,000	8,734,000	12,110,000	84,884,000
Fed. gov't wk	19,000	5,594,000	441,000	47,000	.....	1,186,000	7,287,000
Miscellaneous	301,000	21,348,000	160,000	171,000	382,000	1,227,000	23,589,000
	$8,507,000	$76,848,000	$18,892,000	$32,955,000	$16,846,000	$24,379,000	$178,427,000

Engineering News-Record Construction Cost Index Number

May, 1922	164.62
April, 1922	164.72
May, 1921	210.82
Peak, June, 1920	273.80
1913	100.00

Engineering News-Record's Construction Cost Index Number is practically the same as last month, although there have been certain price adjustments. Structurals are now sold at $1.60 per 100 lb., with a tendency toward $1.70. Cement prices generally firm. Pine lumber cheaper, but fir price is rising with growing demand and scarcity. Average hourly rate for common labor is 42c. Thus, general construction cost is 23 per cent cheaper than one year ago and 40 per cent under the peak; it is 65 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Monthly	
April, 1922	150
March, 1922	202
April, 1921	86
1913	100
Yearly	
1921 (entire year)	88
1920 (entire year)	91
1913	100

Engineering News-Record's Construction Volume Index Number is 150 for the month of April, and 88 for the whole of 1921, as against 100 for 1913. This means that the actual volume of construction in 1921 (not the mere money value of the contracts let that year) is 12 per cent under the volume of construction for 1913. Our monthly volume number, 150 for April, 1922, is really the increment of construction, and indicates the rate at which contracts are being let as compared with 1913 awards.

VALUE OF CONTRACTS LET IN THE UNITED STATES IN FEBRUARY, 1922

	New England	Middle Atlantic	Southern	Middle West	West of Mississippi	Western	Total
Waterworks	.....	$87,000	$20,000	$118,000	$338,000	$89,000	$652,000
Sewers	.....	240,000	410,000	1,521,000	266,000	25,000	2,462,000
Bridges	.....	351,000	136,000	143,000	320,000	145,000	1,095,000
Excavation and dredging	.....	.....	.....	8,000	291,000	.....	299,000
Streets and roads	.....	673,000	2,922,000	3,034,000	1,733,000	690,000	9,052,000
Industrial works	1,855,000	850,000	115,000	2,847,000	440,000	300,000	6,407,000
Buildings	2,103,000	13,013,000	2,201,000	6,190,000	3,070,000	1,142,000	27,719,000
Fed. Gov't work	14,000	158,000	482,000	.....	.....	200,000	854,000
Miscellaneous	122,000	1,612,000	19,000	.....	8,000	761,000	2,522,000
	$4,094,000	$16,984,000	$6,305,000	$13,861,000	$6,466,000	$3,352,000	$51,062,000

$450,000,000 and for the month of February over $200,000,000.

COMPARISON OF VALUE OF CONTRACTS LET DURING APRIL, 1920, 1921, 1922

Classification	April, 1920	April, 1921	April, 1922
Waterworks	$2,719,021	$3,342,150	$2,672,751
Sewers	4,123,907	3,817,401	2,794,468
Bridges	5,586,877	1,987,808	1,677,066
Excavation, dredging	415,512	580,039	1,735,287
Streets, roads	33,340,330	31,026,312	32,991,321
Industrial	65,879,005	9,346,586	11,558,563
Buildings	90,776,835	51,647,900	76,037,497
Federal Gov't.	4,124,269	1,186,403	676,056
Miscellaneous	9,602,630	2,732,799	12,656,358
Total	216,568,386	105,667,398	142,799,367

Large Contracts Are Let During the Week

Among this week's announcements of contracts awarded in Construction News, pp. 211 to 228, are the following large projects:

A plant addition at Buffalo, N. Y., to DuPont Eng. Co., DuPont Bldg., Wilmington, Del., $2,000,000.

An apartment house at Long Island City, N. Y., to Stone & Webster, 120 Bway., New York City, $1,250,000.

A college at New York City, to Nugent Constr. Co., Inc., 21 East 40th St., New York City, $1,000,000.

An apartment house at Philadelphia, Pa., to Metzger, Fisher & White, Otis Bldg., $6,000,000.

Substructure and superstructure of Girard St. piers, Nos. 3 and 5, Philadelphia, to Triest Contg. Co., Penna Bldg., $1,959,798.

A theatre at Chicago, Ill., to Van Etten Bros., 11055 South Michigan Ave., $1,500,000.

Sewers at Detroit, Mich., to Brandon & Hanna, 1624 Dime Bank Bldg., $738,559.

Labor Rates and Conditions Throughout the Country

Industrial conditions in the United States, particularly in the building trades, the lumber, agricultural and manufacturing industries, have shown definite improvement during the past month.

Skilled building trades mechanics have no difficulty in obtaining employment anywhere throughout the country and a very large proportion of the unskilled common labor class has been absorbed by the iron, steel and metal industries and agriculture. Very few wage reductions in the skilled building trades are noted in the 21 cities reporting to *Engineering News-Record* for the month of April, 1922.

Unemployment, exclusive of those involved in the coal, granite, or textile strikes, appears to have reached the highest point in New York state, with Pennsylvania ranking next and Massachusetts third. The states in which industrial conditions are at their best run in the following order: New Jersey, North Dakota, Ohio, Idaho, Utah and Nebraska.

Hoisting engineers were reduced to 70c. from $1, in Atlanta and to $1.12½, from $1.25 per hr. in St. Louis. Structural iron workers rates are quoted at 65c., reduced from $1, in Atlanta and at $1.06, down from $1.06¼ per hr. in St. Louis. Pile drivers receive $1 as against $1.06¼ per hr. in St. Louis. A slight reduction in the common labor schedule quotes 20c.@30c. as against 25c.@30c. in Montreal and 25c.@50c. as compared with 30c.@60c. per hr. in Pittsburgh; bringing the average common labor rate to 42c. per hr. throughout the country.

Although common labor is available at 15c.@20c. per hr. in Birmingham and other points, the Landis award of 72½c. per hr. for pick and shovel men still holds good in Chicago, and in many instances a higher rate is paid.

The standard scale for excavation work is 75c. per hr. in New York City but on construction projects being erected by day labor, as low as 60c.@65c. per hr. is frequently received.

With an unprecedented construction boom already under way, 1921 labor rates still in effect and labor efficiency on the increase, New York building trades show no tendencies toward strikes. Bricklayers and plasterers, taking advantage of scarcity in skilled building trades mechanics do not strike for more pay but leave the job abruptly upon being offered $1@$2 more per day.

The current wage scale in Cincinnati will remain in effect until Dec. 23, 1922 with the exception of the bricklayers. The rate of $1.25 per hr. for bricklayers runs to May 1. The union demands a continuance of this scale but contractors favor a reduction to $1 per hour.

Despite the clash between union and non-union mechanics, building operations in San Francisco continue to gain in volume.

Lumber mills in the Seattle district are running full time with heavy crews. The unemployment situation is well in hand and within the present month nearly all unemployed will have returned to work.

Skilled building trades mechanics practically all employed in Los Angeles. Conditions among the unskilled expected to return to normal during this month.

Scarcity of bricklayers reported in Pittsburgh; all other trades plentiful.

Although the carpenters' wage scale was recently cut to 95c. by the master builders of St. Louis, the trade is now working at $1.12½ per hr. pending final settlement of the controversy.

The number of men employed on construction work in Detroit at the beginning of April, 1922, showed an increase of approximately 15 per cent over the preceding month.

(Higher rates indicated by +, decreases by—)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$0.90	$0.70	—$0.70	$0.30	.....	—$0.65	$0.20
Baltimore	1.25	.80	.87	.54	$0.74	1.00	.30
Birmingham	1.00	.75	.50@1.00	.15@.25	.....	1.00	.15@20
Boston	.90	.90	.90	.60	.90	.90	.40
Cincinnati	1.25	.95	.95	.72½	.77½	.95	.40
Chicago	1.10	1.00	1.10	.....	1.10	1.05	.72½
Cleveland	1.04	1.04	1.04	.60	.91	1.04	.57½
Dallas	1.00	1.00	1.00	.60	1.00	1.00	.25
Denver	—1.25	1.00	1.00	.75@.81½	1.00	1.03½	.35@.50
Detroit	1.00	.80	.80@.90	.50@.60	1.00	.60@.80	.50
Kansas City	1.07½	1.00	1.00	.80	1.07½	1.07½	.....
Los Angeles	1.25	1.00	1.00	1.12½	.87½	1.00	.56½@.62½
Minneapolis	1.00	.80	.80	.65	.....	.80	.40@.50
Montreal	.80	.60	.50	.30@.35	.50	.55	—.20@30
New Orleans	1.00	.88	.90	.40	.80	1.00	.30
New York	1.25	1.25	1.25	.87½	1.00	1.12½	.60@.65
Pittsburgh	1.30	1.00	1.00	.80	1.00	1.00	—.25@.50
St. Louis	1.25	1.12½	—1.12½	.85	—1.00	—1.05	.35@.40
San Francisco	1.12½	1.00	1.00	.75	1.00	1.12½	.47½@.50
Seattle	1.00	.80	.90	.70	1.00	.80@.90	.50@.60
Philadelphia	1.00	.90	.90	.75@90	1.00	.90	.25@.35

Heavy Bond Sales Last Week

Bond sales for the week ending April 28 totaled over $232,000,000, according to the weekly summary of the *New York Times;* the highest previous one-week sale this year was $150,000,000 the week before. The $232,000,000 was thus made up: State and municipal (U. S.), $59,204,000; industrial, $51,050,000; railroad, $11,325,000; utility, $4,500,000; foreign, $106,150,000, of which $100,000,000 were 5 per cent Canadian bonds that sold at par and interest within two hours of the time they were offered.

The most notable American sale was $45,000,000, New York City 4¼ per cent 50-year refunding bonds, which sold at 104, to yield 4.06. A Newark, N. J., issue of $3,503,000 4½ per cent 1-39-year improvement bonds sold to yield 4.10.

Of 19 state and municipal offerings the interest rates of two were 4¼ per cent; of five, 4½; of one, 4¾; of six, 5 to 5½; and of five, 6 per cent. The yield rate of 8 of the 19 issues was 4¼ per cent or less, and of 12, 4½ per cent or less.

Production Paragraphs

Building permits issued in 166 cities amounted to $259,508,703 in March compared with $141,715,243 in February and $126,472,031 in March, 1921. Increases in March over February varied from 18 to 188 per cent, while increases over March, 1921, ranged from 8 to 238 per cent.

Production and shipments of lumber, brick, cement and other building materials increased in March in response to the greater volume of construction. The marked increase in the movement of enamel sanitary ware is indicative of the increase in building.

Copper exports in March totaled 80,853,000 lb. showing a marked gain over recent months and registered the largest total for any month in nearly two years. Imports of both tin and zinc were larger. Tin imports for March at 15,783,000 lb., have been exceeded only once in the last two years.

Petroleum industry set new high records in March. Production of crude totaled 46,916,000 bbl. compared with the previous record output last January of 43,141,000 bbl.

Automobile factories' March production totals 152,920 passenger cars, compared with 109,121 in February. Truck production totaled 19,422 or approximately 5,000 more than the February output.

Iron and steel export trade in March increased 55 per cent over February and was the largest since March last year. Imports of iron and steel also increased 2,000 tons, with a total of 14,000 tons, which is the largest amount imported in one month since January, 1921.

Railroad and steel companies' reports indicate the country's business is weathering the coal strike with comparative inconvenience.

Car Surplus and Freight Loading Gain in Week

Serviceable surplus cars totaled 333,393 for the week ending April 15, according to statistics compiled by the Car Service Division of the American Railway Association. This is an increase of 73,788 cars over the previous week, and the first gain recorded in many months. Of this, the principal increase, or 65,559 was coal cars, due to the miners' strike, 6,293 were box cars and the balance miscellaneous.

Loadings of revenue freight for the week ending April 15 totaled 706,713 cars, an increase of 4 597 cars over the corresponding week in 1921.

Decline in coal and coke loading due to the strike of the miners continues to be the contributing factor in the reduction in revenue freight loading. Grain and grain products loading declined 1,729 cars compared with the preceding week, and ore loading decreased slightly. Loading of lumber, merchandise and miscellaneous are steadily increasing.

Generally speaking, revenue freight loading other than coal and coke holds up very well. This average loading for the past three weeks is on the basis of 83 per cent of the average for the three record weeks in October, 1920.

SURPLUS AND SHORTAGE STATEMENT—April 8 to 15, 1922

Districts	Flat Cars		All Box Cars		All Coal Cars		Total All Cars	
	Surplus	Shortage	Surplus	Shortage	Surplus	Shortage	Surplus	Shortage
Eastern	1,510	..	18,360	37	71,416	..	95,939	37
Allegheny	630	..	13,645	..	71,908	..	88,551	..
Pocahontas	226	..	647	..	4,432	..	6,272	..
Southern	2,550	43	8,375	132	13,199	38	28,254	238
North Western	1,849	..	25,307	..	2,406	..	36,372	..
Central Western	1,595	..	24,275	25	21,461	50	61,413	75
South Western	686	..	9,877	8	3,186	..	16,792	8
Total	9,046	43	98,686	202	187,918	88	333,393	358
Canadian Roads	3,600	..	23,850	..	2,030	..	36,515	..
Grand total	12,646	43	122,536	202	189,948	88	369,908	358
April 8, 1922	13,595	40	118,208	185	123,709	114	298,830	349

Monthly Prices of Construction Materials

Ups and Downs of the Market

Pig Iron—Scarcity of pig iron causes advance of 50c.@$1 in Philadelphia and $2@$3 per ton in Pittsburgh; firmer prices at Birmingham.

Railway Supplies—Light rails up $1 per ton at Pittsburgh mills. Slight advance in white oak ties in St. Louis. Spikes up 10 c.@15c.; track bolts 10c.@50c. and section angle bars 90c. per 100 lb., Pittsburgh. Larger specifications for car materials are being placed by the railroads.

Pipe—Rise in pig iron reflected in cast-iron pipe advances of $1 in Chicago, $1.50 in Birmingham and $2 per net ton in San Francisco. New York prices firmer. Big drop in clay drain tile in San Francisco. Sewer pipe also down in St. Louis, Seattle, New Orleans, Atlanta and Detroit.

Road and Paving Materials—Wood blocks quoted in Atlanta at $2.30 as against $2.09 per sq.yd. Wood blocks, asphalt and road oils all firmer in tone with price tendencies upward, induced by extensive road building operations.

Sand, Gravel and Crushed Stone—Both sand and gravel quoted at $1.80 as against $2 per cu.yd. in Chicago. Sand, gravel and crushed stone prices fairly firm throughout the country; crushed slag down 15c. per ton in Birmingham.

Lime—Lump finishing lime quoted at $2.35 as against $2.50 in St. Louis and at $2.80 as compared with $3 per bbl. (180 lb. net) in Seattle. Prices stable elsewhere.

Structural Material—Steel shapes, plates and bars quoted at $1.60 per 100 lb., Pittsburgh. Several producers quoting as high as $1.70. Rise in mill price reflected in advances of 10c. per 100 lb. in New York and Chicago warehouses. Structural rivets up 15c. in New York and 10c. per 100 lb. in Chicago. Slight advance in wire nails at Pittsburgh mills. Declines in prices of triangle mesh in New York and expanded metal lath in Chicago warehouses. Rise of $2 per ton in steel sheets at Pittsburgh results in similar advances in San Francisco, St. Louis, Chicago and New York warehouses.

Brick and Hollow Tile—Common brick, New York, quoted at $17 per 1,000, wholesale; demand continues heavy with inadequate supply. Salmon brick down $2 in St. Louis. Rise in hollow tile in Atlanta; decline in St. Louis. Prices stable elsewhere.

Roofing Materials—Asphalt roofing quoted in New York at $40.50 as against $47.50 and asphalt felt (light) at $64.50 as compared with $67 per ton, f.o.b. plant.

Lumber—Yellow pine down $1 in Chicago and Douglas fir, $2 per M ft. in San Francisco. Decline of $3 in Douglas fir and hemlock in Los Angeles. All lumber up $2 in Denver; fir, $1 per M ft. in Minneapolis. Increase in Denver due to heavy demand and shortage at mills. Demand also increasing in Seattle, particularly from Eastern seaboard, California and the Orient.

Piles—Average drop of 1½c. per lin. ft. in pine piles, New York. Steel sheet piling up 25c. per 100 lb., Pittsburgh.

Scrap—Steel scrap prices up $1 per gross ton, New York. Scarcity of pig iron inducing furnaces to use steel scrap.

Manila Rope—Advances of ½c. in Detroit, 1c. in Atlanta, 1½c. in Seattle and 2½c. per lb. in St. Louis.

Explosives—Slight advances in dynamite in Los Angeles and Seattle.

Linseed Oil—Raw oil quoted at 91c. as against 82c.@83c. per gal. (5 bbl. lots) one month ago, in New York. Prices tending upward throughout the country.

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton—Quotations compiled by The Matthew Addy Co.:

	Current	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	$20.50†	$29.50
Northern Basic	*20.78*†	27.52
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	*20.50*†	28.52
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	*26.16*†	35.26
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	**16.50**†	24.00
PHILADELPHIA		
Eastern Pa., No. 2X, (2.25 @ 2.75 sil.)	**22.34**†	26.25@28.50*
Virginia No. 2 (silicon 2.25 @ 2.75)	**28.24**†	28.00*
Basic	*20.25*†	26.25†
Grey Forge	**21.00**†	27.00*
CHICAGO		
No. 2 Foundry Local (silicon 1.75 @ 2.25)	20.00†	24.00
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	*16.00*†	32.92
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	**21.96**†	26.96
Basic	**21.46**†	26.86
Bessemer	**21.96**†	27.00

*F.o.b. furnace. † Delivered.

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh			
	Current	One Year Ago	Birmingham	Chicago
Standard bessemer rails	$40.00	$45.00	.....	$40.00
Standard openhearth rails	40.00	47.00	$40.00	40.00
Light rails, 8 to 10 lb.	**30.00**	2.30*	1.60*	1.60@1.70*
Light rails, 12 to 14 lb.	**30.00**	2.25*	1.60*	1.60@1.70*
Light rails, 25 to 45 lb.	**30.00**	2.20*	1.60*	1.60@1.70*
Rerolled Rails	*28.00*	.....	.....	.....

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	$1.35	$1.50
Chicago, Hardwood and Red Oak	1.20	1.30
Chicago....Empty Cell Creosoting (add'l)	.45	.50
San Francisco..... Green Douglas Fir	.85	1.10
San Francisco, Empty Cell Creosoted, Douglas Fir	1.86	2.30
St. Louis, White Oak*	1.10	**1.44**
St. Louis, Red Oak*	.97	1.17
St. Louis (creosoted)	No. 1, $0.86;	No. 2, $0.96; No. 4, $1.28

*Standard specifications 38c. per tie additional. Zinc chloride process 27c. per tie additional.

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Current	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅜-in. and larger	**$2.15@2.25**	$3.30	$2.55	*$3.00*	$4.25	$3.10
Track bolts	**3.00@3.50**	4.35	3.65	*4.25*	5.25	4.05
Standard section angle bars	**2.40**	2.50	2.40	*3.00*	4.00	3.25

PIPE

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
to 3	71	58½	¼ to 1¼	44½	29½
1 to 1¼	69	57½	⅜ to 1¼	44½	30½
2 to 3	70	58½			

LAP WELD

2	64	51½	2	39½	25½
2½ to 6	68	55½	2½ to 6	42½	29½
7 to 8	65	51½	7 to 12	40½	27½
9 to 12	64	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	62	50½	2	40½	27½
2½ to 4	66	54½	2½ to 4	43½	31½
4½ to 6	65	53½	4½ to 6	42½	30½
7 to 8	61	47½	7 to 8	35½	23½
9 to 12	55	41½	9 to 12	30½	18½

STEEL—From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	66%	62½%	59%
2½ to 6 in. lap welded	61%	59½%	56%

	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	53%	48½%	45%
2½ to 6 in. lap welded	47%	45½%	42%

Malleable fittings, Class B and C, from New York stock sell at list less 10%. Cast iron, standard sizes, *32-5%* off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York					
	Current	One Year Ago	Birmingham	Chicago	St. Louis	San Francisco
4 in.	**$50.80@51.80**	$73.30	**$38.50**	**48.10@48.60**	$43.70	**$54.00**
6 in. and over	**46.80@47.80**	63.30	**34.50**	**44.10**	39.70	**50.00**

Gas pipe and Class "A," $4 per ton extra; 16-ft. lengths, $1 per ton.

CLAY DRAIN TILE—The following prices are per 1000 lin.ft.:

	New York					
Size, In.	Current	One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$40.00	$50.00	....	$50.00	.....	$55.00
4	50.00	60.00	$80.00	60.00	*$76.50*	65.00
5	80.00	90.00	....	80.00	*97.75*	84.00
6	100.00	115.00	140.00	100.00	*127.50*	110.00
8	150.00	185.00	200.00	150.00	*212.50*	181.00

SEWER PIPE—The following prices are in cents per foot for car load lots f.o.b.:

Size, In	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	$0.14	$0.087	.....	.....	$0.12	**$0.12**	.....
4	.14	.087	$0.08	*$0.0875*	.12	.15	**$0.18**
5	.21	.1305	.10	.....	.18	.18	.165
6	.21	.1305	.12	*.1225*	.18	.21	.25
8	.35	.203	.20	*.20*	.28	.30	.33
10	.52	.3045	.26	*.28*	.42	.42	.....
12	.67	.3915	.30	*.36*	.54	.54	**.80**
15	1.15	.522	.50	**.52**	.72	.90	.....
18	1.55	.725	.68	*.68*	1.00	1.32	.....
20	1.98	.87	.90	*.92*	1.20	.....	.....
22	2.64	1.16	1.10	.....	1.60	.....	.....
24	2.97	1.305	1.30	*1.20*	1.80	2.16	**2.40**
27	4.50	1.885	....	*2.00*	3.75	3.00	.....
30	5.00	2.088	....	*2.45*	4.75	3.60	.....
33	6.55	2.61	....	*3.00*	5.50	.....	.....
36	7.50	2.9725	....	*3.25*	6.00	.....	.....
	3	5	8	12	24	36	
Boston	$0.105	$0.1575	$0.245	$0.4725	$1.575	$4.408	
Minneapolis	.....	.....	.40	.77	2.55	5.66	
Denver	.135*	.18*	.27	.47	1.70	.....	
Seattle	*.13*	.....	*.32½*	*.65*	*2.5½*	.....	
Los Angeles	.11*	.165*	.275	.495	1.65	.....	
New Orleans	.....	*.106*	.27	.459	**1.756**	.....	
Cincinnati	.096	.144	.224	.43	1.44	4.382	
Atlanta	.078*	.117*	.195	.3315	*1.15*	.....	
Montreal, *delivered*	.30*	.45*	.70*	1.35	4.50	6.50	
Detroit	*.099*	*.1485*	*.231*	*.4455*	*1.935*	*5.125*	
Baltimore	.1225	.2275	.35	.6870	2.29	5.23	
Kansas City, Mo.	.15*	.21*	.335	.60	2.41	4.74	
Philadelphia	.105	.1575	.245	.4725	1.575	3.5875	

*4-in., 6-in., 9-in., respectively.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

	Current	One Year Ago
New York, 45% asphalt (at terminal)	$0.05	$0.07
New York, 65% asphalt (at terminal)	.045	.07
New York, binder (at terminal)	.055	.07½
New York, flux (at terminal)	.05	.07
New York, liquid asphalt (at terminal)	.06	.08
St. Louis, 30-50% asphalt (*f.o.b.*) *Wood River, Ill.*	**.05**	.04*
Chicago, 40-50% asphalt	.05	.06
Chicago, 60-70% asphalt	.05½	.06½
Dallas, 40-50% asphalt	.10	.10
Dallas, 60-70% asphalt	.13	.13
Dallas, 75-90% asphalt	.15	.15
San Francisco, binder, per ton	13.00†	15.00

* Freight $21.75 per ton to Whiting, Ind.
† F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots:

	Package	Bulk
New York (Bayonne, N. J.)	$25.00	$15.00
Boston	No quotations	
Chicago	24.35	18.0.
San Francisco *f.o.b. refinery*, Oleum, Cal. (natural)	19.50*	13.50*
Dallas	35.00	27.00
Seattle	28.90	....
Denver	40.00	....
Minneapolis	....	19.95
St. Louis (natural)	*22.35*	*14.00*
Baltimore	25.00	20.00
Los Angeles, *at factory*	22.50	15.00
Montreal	28.00	21.00
Atlanta	28.00	....
Detroit (petroleum asphalt)	25.00	19.00
Cincinnati	32.00	28.00
Maurer, N. J. (natural asphalt)	36.00	33.00
Maurer, N. J. (artificial asphalt)	22.00	20.00
Philadelphia	24.00	17.50
Kansas City	28.83	22.83

*Freight to San Francisco, 80c. per ton.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums. Rebates of about $1 per bbl., no rebate for drums.

PAVING STONE—

New York	5-in. granite, 28@29 blocks per sq.yd.	$130.00 per M	
Chicago	About 4x8x4 dressed	3.20 sq.yd.	
	About 4x8x4 common	3.00 sq.yd.	
San Francisco	Basalt block 4x7x8	70.00 per M	
Boston	5-in. granite	125.00 per M	
Atlanta	Granite	2.00 sq.yd.	
Detroit	Granite, 26½ blocks per sq.yd.	3.05 sq.yd.	
Baltimore	Granite	2.00 sq.yd.	
Montreal	Granite	125.00 per M	
New Orleans	Granite, 4 x 8 x 4	3.25 sq.yd.	
Cincinnati	Granite	3.84@4 sq.yd.	
St. Louis	4x8x4 dressed	3.35 sq.yd.	
	4x8x4 common	3.00 sq.yd.	
Kansas City	No. Granite	3.95 sq.yd.	
Philadelphia	Granite	125.00 per M.	

FLAGGING—

New York	Bronx	$0.25	sq.ft.
	Manhattan, 4 ft.	.26	sq.ft.
	Queens, 5 ft.	.26	sq.ft.
	6x20-in. cross-walk	1.00	lin.ft.
Chicago	18 in. wide	.99	lin.ft.

CURBING—Bluestone per lineal foot, in New York, costs 77c. for 5x16 in., 88c. for 5x18 in.; in cargo lots.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York (*delivered*)	3	16	$2.04
New York (*delivered*)	3½	16	2.17
New York (*delivered*)	4	16	2.36
Boston	3	16	2.17
Chicago	4	16	3.00@3.25
Chicago	3½	16	2.50@2.75
St. Louis	3½	16	2.50
St. Louis	4	16	3.00
Seattle	4	16	Off market
Minneapolis	3½	16	2.13
Atlanta	3½	16	2.30
New Orleans	3	16	1.60
New Orleans	3½	16	1.80
New Orleans	4	16	2.00
Dallas	4	18	3.90
Baltimore	3½	16	3.44
Montreal	4	16	4.50
Detroit	3	16	2.84
Detroit	4	16	3.00
Cincinnati	4	16	2.10
Kansas City	4	16	2.15
Philadelphia	3½	16	3.50

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In. Current	Gravel 1½ In. One Year Ago	Gravel ¾ In. Current	Gravel ¾ In. One Year Ago	Sand Current	Sand One Year Ago
New York	$1.75	$2.50	$1.75	$2.50	$1.00	$1.25
Denver	2.50	2.00	2.50	1.80	1.10	1.60
Chicago	*1.80*	2.75	*1.80*	2.75	*1.80*	2.75
St. Louis, *per ton*	1.25	1.55	1.30	1.60	1.10	1.60
Seattle	1.50	1.50	1.50	1.50	1.50	1.50
Dallas	2.25	3.50	2.25	4.00	2.25	3.00
Minneapolis	1.50	2.00	1.50	....	1.00	1.00
Cincinnati	1.87½	2.56½	1.87½	2.62½	1.43	1.95
San Francisco	2.25	2.50	2.25	2.50	1.50	1.65
Boston	2.40	2.65	2.40	2.65	1.65	2.00
New Orleans	2.08½	2.85	2.08½	....	1.35	1.65
Los Angeles, per ton	1.50†	1.55	1.50†	1.45	1.35†	1.00
Atlanta, per ton	1.85	2.62½	1.85	....	1.15	1.52½
Detroit	2.00	2.50*	2.00	2.50*	2.00	2.50
Baltimore, per ton	1.40	1.40‡	1.60	1.60‡	2.00	.70
Montreal, per ton	1.25	1.50‡	1.50	1.75	1.25	1.50
Birmingham, per ton (Crushed slag used instead of gravel)					1.25	1.43‡
Philadelphia	1.50	....	1.55	....	1.60	....
Kansas City	2.00	3.25	2.00	3.75	1.20	1.25

* Fine white sand: Pacific, $4 per ton; Ottawa, $4.50

† Freight from quarry to Los Angeles is 85c. per ton, and is included in above price.

‡ Per cu. yd.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless stated otherwise, is as follows, per cu.yd.:

	1½ In. Current	1½ In. One Year Ago	¾ In. Current	¾ In. One Year Ago
New York	$1.65	$1.90@2.00	$1.75	$2.15
Chicago	1.60	2.75	1.60	2.75
St. Louis *delivered*	1.65	2.60	1.65	2.60
Dallas, *delivered*	2.73	2.80	2.73	2.80
San Francisco	2.25	2.50	2.25	2.50
Boston, *delivered*	3.00*	3.00* (del.)	3.00*	3.00* (del.)
Minneapolis, *at plant*	2.00	2.00	2.25	2.25
Kansas City, *at plant*	2.10	2.52	2.10	....
Denver	3.50	....	3.50	....
Seattle *delivered*	3.00	3.50 (del.)	3.00	3.50 (del.)
Atlanta	1.90*	2.50*	1.90*	....
Cincinnati *delivered*	1.75	3.06½	1.75	3.06½
Los Angeles	1.75*	1.75*	1.85*	1.80*
Detroit	1.90*	2.00*	1.90*	2.00*
Baltimore	1.75*	1.75*	1.65*	1.75*
Montreal	2.00*	2.00*	*2.00**	2.10*
Birmingham *delivered*	3.20	....	3.10	....
Phildelphia	1.70*	....	1.55*	....
Pittsburgh	2.85	....	2.85	....
Cleveland	3.25*	....	3.25*	....

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.30	$2.00	$1.30
Steubenville District	1.40	1.40	2.00	1.40
Ironton District	1.40	1.40	2.00	1.40
Emporium, Pa.	1.25	1.25	....	1.25
Easton, Catasaqua, Pa.	1.00	1.00	2.00	0.90
Birmingham, Ala.	*0.90*	*1.00*	....	*0.50*
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.20	1.20	....	1.00
Eastern Pennsylvania and Northern New Jersey	1.20	1.20	2.00	1.20
Western Pennsylvania	1.25	1.25	2.00	1.25

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$15.80@$16.80	$12.50	$3.68	$2.75@$3.18*
Chicago	18.00	....	....	1.40†
St. Louis	23.20	20.00	*2.35*†	....
Boston	23.00	19.50	3.30†	3.00†
Dallas	25.00	....	....	2.50†
Cincinnati	15.10	12.50	10.75	12.50‡
San Francisco	22.00	18.00	....	1.75†
Minneapolis	29.00	22.00 (white)	1.70†	1.40†
Denver	24.00	....	....	2.70†
Detroit	18.00	16.00	....	17.00‡
Seattle *p per sacks*	*2.00*		*2.80*†	2.75†
Los Angeles	30.00	30.00	3.00	3.00*
Baltimore	15.00	13.00	....	12.00‡
Montreal	21.00	21.00	15.00‡	11.00‡
Atlanta	18.00	12.50	2.00†	1.25†
New Orleans	....	17.25	1.75†	....
Philadelphia	13.00	11.50	10.50‡	9.50‡

*280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl.

Minneapolis quotes brown lime; Kelly Is. white is $1.70, Sheboygan $1.55.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b., exclusive of bags:

	Current	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.60	1.60
Atlanta (Magnolia)	11.00 ton	11.00
Cincinnati (Utica)	1.77	2.75
Boston (Rosendale) per bag	.80	3.00
St. Louis (Carney hydrated)	2.10	....

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Current	One Month Ago	One Year Ago
New York*	$2.40	$2.30	$3.20
New York, alongside dock to dealers	2.30	2.00	2.35
Jersey City	2.12	2.12	2.67*
Boston	2.50	2.50	2.62
Chicago	1.97	1.94	2.17
Pittsburgh	2.02	2.02	2.17
Cleveland	2.26	2.26	2.43
Detroit	2.17	2.17	2.43
Indianapolis	2.21	2.21	2.43
Toledo	2.20	2.20	2.49
Milwaukee	2.18	2.13	2.39
Duluth	*1.94*	1.95	2.10
Peoria	2.08	1.98	2.45
Cedar Rapids	2.21	2.11	2.51
Davenport	2.16	2.06	2.47
St. Louis	2.20	2.20	2.80
San Francisco	2.73	2.73	2.63
New Orleans	3.00	3.20	2.96
Minneapolis	2.24	2.24	2.41
Denver	2.90	2.90	2.82
Seattle	2.94	2.94	3.03
Dallas	2.25	2.40	2.15
Atlanta	2.39	2.39	2.70
Cincinnati	2.35	2.32	2.57
Los Angeles	3.30	3.30	3.85
Baltimore*	2.50	2.50	....
Birmingham	2.27	2.27	....
Kansas City	2.40	2.40	2.56
Montreal	2.50	2.50*	2.95
Philadelphia	2.21	2.21	....
St. Paul	2.24	2.24	2.41

NOTE—Bags 10c. each, 40c. per bbl.;

Current mill-prices per barrel in carload lots, without bags; to contractors:

Buffington, Ind.	$1.70	Mason City, Ia.	$1.95
Universal, Pa.	1.75	Hudson, N. Y.	1.90
Steelton, Minn.	1.75	Leeds, Ala.	1.95
Fordwick, Va.	1.95	Hannibal, Mo.	1.85
Mitchell, Ind.	1.95	Lehigh Valley District	1.70
LaSalle, Ill.	1.70	Kingsport, Tenn.	1.95
Iola, Kan.	1.95	Richard City, Tenn.	1.95

*Delivered by truck at site of work.

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh, Mill	Warehouse: New York	Chicago	Dallas	San Francisco
032	22	$0.68	*$0.95*	$0 76	$1.15	$1 15
049	28	.87	*1.23*	98	1 46	1 48
068	35	1.05	*1.48*	1 18	1 80	1 80
093	45	1.35	*1.91*	1 52	2 30	2.32
126	57	1.65	*2.35*	1 87	2.86	2.87
153	68	1.97	*2.81*	2 23	3.40	.....
180	78	2.26	*3.22*	2 56	3.93	.....
245	103	2.99	*4.25*	3 38	5 15	.....
287	119	3.45	*4.90*	3 90	5.96	6.01
336	138	4.00	*5.69*	4 52	7.32	.....
395	160	4.64	*6.60*	5.20	8.00	.....
			PAVING			
036P	17	$0.52	*$0.72*	$0.58	$0.88	.....
053P	24	.73	*1.02*	.82	1.24	.....
072P	31	.91	*1.29*	1 00	1 57	.....
097P	40	1.18	*1.67*	1.29	2.02	.....
049R	24	.73	*1.02*	.67	1 24	.....
067R	31	.91	*1.29*	1.00	1 57	.....
089R	40	1.18	*1.67*	1.29	2.02	.....

In rolls 16-, 20-, 24-, 28-, 32-, 36-, 40-, 44-, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in wide x 150 ft. long, or 600 sq. ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Gage	Weight	*New York	Chicago	St. Louis	San Francisco	Dallas
27BB	2.3	$21 20	*$20.39*	$21 25	$23 87	$25 50
26BB	2.5	22.65	*22.00*	22 75	26 21	27.56
25BB	3.0	25 30	.....	27.10	.....	30.71
24BB	3.4	27 10	*26 33*	29 25	27.90	33.16
22PO	4.33	31.75	**31 00**	31.75	.....	35.10

* Price to contractors at warehouse or delivered on job in Manhattan, Bronx or Brooklyn.

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	**$1 60**	$1 60	**$2 48**	**$2 38**	*$2 47½*	$3 50	$2 55
⅝ and larger	**1 65**	1.65	**2 53**	**2 43**	*2 52½*	3 55	2 60
¾ and larger	**1 70**	1.65	**2 58**	**2 48**	*2 57½*	3 60	2.65
⅞ and larger	**1 85**	1 70	**2 63**	**2 63**	*2 72½*	3.75	2.80
1 and larger	**2 10**	1.70	**2 68**	**2 88**	*2 97½*	4.00	3.05

Includes 15c charge for cutting to lengths of 2 ft. and over.
Twisted bars cut to length take extra of 27½c. per 100 lb.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ and larger	**$1 60**	$2 25	$3 25	½	**$1 85**	*$2 50*	$3 50
⅝ in	**1 65**	**2 30**	3 30	¼	**2 10**	2 75	3 75
¾	**1 70**	2.35	3.35	.....	.....	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Current	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.)	**20.40**	$19.40@19.90	$18 40	**$44.50†**	**$49.50†**
New York (at dock)	**17.00**	16.00@16.50	15.00	.....	.....
Chicago	11.00	11.00	12 00	34.00	42 00
St. Louis, salmon	*14.00*	16.00	15 00	.....	*28.00*
Denver, salmon	12 00	12 00	14.00	.....	.....
Dallas	11 15	11 15	16.00	no market	
San Francisco	15 00	15 00	18 00	.....	.....
Los Angeles	15 00	15 00	15 00	(not used)	
Boston (del.)	16 00	16 00	21 75	46.50†	52 60†
Minneapolis (del.)	15 00	15 00	18@20	.....	43.00
Kansas City	14 50	14 50	20 00	.....	.....
Seattle	14 00	14 00	19 00	*44 00*	.....
Cincinnati	15 00	15 00	20.00	41.00	36.50
Montreal (del.)	16 00	16 00	18 00	.....	*68 00*
Detroit (del.)	16.50	16 50	18.00	*36 50*	*39.50*
Baltimore (del.)	20 00	20 00	20@25	36 00‡	.....
Atlanta	9 00	9 00	12 00	.....	.....
New Orleans	12 50	12 50	17.50	.....	.....
Birmingham	9 50	9 50	.....	.....	.....
Philadelphia	16.00	16.00	.....	.....	42.00
Pittsburgh (del.)	17.50	.....	.....	.....	.....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. † F.o.b. ‡ Vitrified, f.o.b. plant, Baltimore.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Current on Trucks*	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12	$0.11120	$0.1895	$0.0821	$0.095	*$0.0635*	$0.108	.....
6x12x12	.16670	.2526	.0950	.....	*.08*	.156	.....
8x12x12	.20840	.....	.1295	.175	*.12*	.244	$0.17890
10x12x12	.....	.....	.1584	.....	*.16*	.....	.21050
12x12x12	.....	.....	.1811	.255	*.185*	.....	.27370

* 5 per. off for cash.

	4x12x12	8x12x12	12x12x12
Boston	$0.94	$0.177	$0.244
Minneapolis (f.o.b. cars)	.0672	.105	.168
Minneapolis (delivered)	.0752	.1175	*.180*
Cincinnati	.0670	.1263	.175
Kansas City	.085	.167	.270
Denver	.08	.145	.21
Seattle	.12	.25	.30
Los Angeles factory	.095	.176	.22
New Orleans	.12	.23	*.36*
Detroit (delivered)	.070	.135	.225
Montreal	.095	.18	*.30*
Baltimore	.14	.25	.39
Atlanta	**.072**	**.12**	.....
Dallas	.115	.....	.....
Birmingham	.09	*.16*	.....
Pittsburgh (del.)	.066	.124	.179

San Francisco, Philadelphia and New York quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburgh and Birmingham together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh, Mill	Birmingham Mill	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	**1.60**	**$1.65**	**$2.58**	**$4.00**	**$2.57½**	**$2.48**	**$3.10**
Channel, 3 to 15 in.	**1.60**	1.65	**2.58**	**4.00**	**2.57½**	**2.48**	**3.10**
Angles, 3 to 6 in., ¼ in. thick	**1.60**	1.65	**2.58**	**4.00**	**2.57½**	**2.48**	**3.10**
Tees, 3 in. and larger	**1.60**	1.65	**2.58**	**4.00**	**2.57½**	**2.48**	**3.10**
Plates	**1.60**	1.65	**2.58**	**4.00**	**2.57½**	**2.48**	**3.10**

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh, Mill	Warehouse: New York, Current	New York, One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in. and larger	**$2.10@2.25**	**$3.50**	**$4.65**	**$3 10**	$3 09½	$4.50	$5 50

CONE HEAD BOILER

½ in. and larger	**2.20@2.35**	**3.60**	4.75	**3.20**	**3.19½**	4.60	5.65
⅝ and ¾	**2.35@2.50**	**3.76**	4.90	**3.35**	**3.35½**	4.75	5 80
⅞ and 1	**2.60@2.75**	**4.00**	5 15	**3.60**	**3.59½**	5.00	6.05

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in. take an extra of 25c.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	**$2.40@2.50**	**$3.15**	$3.90	$5 00	*$3.25*	$4 95
Cut	2.25	5.80	5.90	7.75	.....	5.00

PREPARED ROOFINGS—Standard grade rubbered surface, complete with nails and cement, costs per square as follows:

	New York: 1-Ply l.c.l.	New York: 2-Ply l.c.l.	New York: 3-Ply l.c.l.	Philadelphia: 1-Ply l.c.l.	Philadelphia: 2-Ply l.c.l.	Philadelphia: 3-Ply l.c.l.
No. 1 grade	$2 00	$2.45	$2.90	$1 90	$2 35	$2 80
No. 2 grade	1.80	2.10	2.50	1.70	2.00	2.40

Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $1.95 per roll in carload lots and $2.20 for smaller quantities f.o.b. Philadelphia.

Shingles, red and green slate finish, cost $5.50 per square in carloads; $5.75 in smaller quantities, in Philadelphia.

ROOFING MATERIALS—Prices f.o.b. New York:

Tar felt (14 lb. per square of 100 sq.ft.) per roll of 432 sq.ft.	$2 00
Tar pitch (in 400-lb. bbl.), per 100 lb.	1 60
Asphalt roofing (in barrels), per ton, f.o.b. plant*	*40.50*
Asphalt felt (light), per ton, f.o.b. plant*	*64.50*
Asphalt felt (heavy), per ton, f.o.b. plant*	68.50

* Delivered in Metropolitan Dist., $3,00 additional.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	**$2.40**	**$3 62½**	$3 38	**$4.15**	**$3.38**
No. 12	**2.45**	**3.67½**	3 43	**4 20**	**3.43**
No. 14	**2.50**	**3.72½**	3 48	**4 25**	**3.48**
No. 16	**2.70**	**3.82½**	3 58	**4 35**	**3.58**
Black					
*Nos. 18 and 20	**3.00**	**3.70**	**4 10**	**5 45**	**4 05**
*Nos. 22 and 24	**3 05**	**3.85**	**4 15**	**5 50**	**4 10**
*No. 26	**3 10**	**4.00**	**4.20**	**5 55**	**4 15**
*No. 28	**3.15**	**4.30**	**4.30**	**5 65**	**4.25**
Galvanized					
No. 10	**3.15**	**4.30**	**4 30**	.....	**4.25**
No. 12	**3.25**	**4.40**	**4.40**	**5.60**	**4.35**
No. 14	**3.25**	**4.40**	**4.40**	**5 60**	**4.35**
Nos. 17 to 21	**3.55**	**4.60**	**4.70**	**5 90**	**4.65**
Nos. 22 and 24	**3.70**	**4.85**	**4.85**	**6.05**	**4.80**
*Nos. 25 and 26	**3.85**	**5.00**	**5 00**	**6.20**	**4.95**
*No. 28	**4.15**	**5.30**	**5.30**	**6 50**	**5.25**

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Current	New York: One Year Ago	Chicago: Current	Chicago: One Year Ago
Raw in barrel (5 bbl. lots)	**$0.91**	$0 67	$0 90	$0.68

WHITE AND RED LEAD—Base price in cents per pound:

	Red — Current		Red — 1 Year Ago		White — Current	White — Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry or In Oil	Dry or In Oil
100-lb. keg	12.25	13.75	13.00	14.50	12.25	13.00
25 and 50-lb. kegs	12.50	14.00	13.25	14.75	12.50	13.25
12½-lb. keg	12.75	14.25	13.50	15.00	12.75	13.50
5-lb. cans	15.25	16.75	16.00	17.50	15.25	16.00
1-lb. cans	17.25	18.75	18.00	19.50	17.25	18.00

LUMBER

Prices wholesale to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M ft. additional.

	6–8 and 12 Ft.	10–16–18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$24.00	$24.00	$25.00	$30.00
3x6 and 8	25.00	25.00	26.00	31.00
4x4-6 and 8	25.00	26.00	27.00	32.00
3x10 and 12	25.00	26.00	27.00	32.00
3x14	29.00	30.00	31.00	33.00
4x10 and 12	25.00	26.00	27.00	32.00
x14	29.00	30.00	31.00	33.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft
6x10	$27.00	$30.00	$32.00
6x14	29.00	32.00	34.00
8x10	27.00	30.00	32.00
8x14	29.00	32.00	34.00

New York, Chicago, St. Louis and Detroit—Wholesale prices to dealers of long leaf yellow pine.

	New York* — 20 Ft. and Under	New York* — 22–24 Ft.	Chicago — 20 Ft. and Under	Chicago — 22–24 Ft.
3x 4 to 8x8	$38.00	$39.00	$36.00	$38.00
3x10 to 10x10	41.00	42.00	38.00	40.00
3x12 to 12x12	43.00	44.00	40.00	42.00
3x14 to 14x14	47.50	48.50	44.00	46.00
3x16 to 16x16	52.50	53.50	49.00	51.00
3x18 to 18x18	60.00	61.00	55.00	57.00
4x20 to 20x20	70.00	71.00	62.00	64.00

* Wholesale price to dealers; to contractors, on lighters or cars, about $5 additional. Short leaf pine up to 14 x 14 costs $15 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12 x 12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under. For pine add $2 to the price of merchantable for all sizes.

Other Cities	8 x 8-In. x 20 Ft. and Under — P.	Fir	Hemlock	Spruce	12 x 12-In. 20 Ft. and Under — P.	Fir
Boston	$50.00	$52.00	$55.00	$45.00	$54.00	$52.00
Seattle		20.00	.....	.....	.....	20.00
New Orleans	20.00	.....	.....	.....	25.00	.....
Baltimore	36.45	.....	.....	.....	38.50	.....
Cincinnati	39.00	50.00	.....	.....	40.00	64.00
Montreal	.....	47.00	35.00	35.00	82.00	47.00
Los Angeles	.....	41.00	40.00	.....	.....	41.00
Denver	.....	35.75	35.75	35.75	.....	36.75
Minneapolis	40.00	39.00	38.00	.....	47.00	39.00
Atlanta	30.00	.....	.....	.....	36.00	.....
Dallas	33.00	.....	.....	.....	34.50	.....
Kansas City	33.00	34.00	.....	.....	36.00	35.00
Birmingham	21.00	.....	.....	.....	26.00	.....
Philadelphia	35.00	36.00	39.00	44.00	44.00	36.00
Detroit	40.00	43.00	.....	.....	45.00	44.00
St. Louis	35.00	.....	.....	.....	38.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under — P.	Fir	Hemlock	2-In. T. and Gr. 10 In. x 16 Ft. — P.	Fir
Boston	$47.00	$48.00	$32.00	$45.00	$48.00
Seattle	.....	16.00	.....	.....	18.50
New Orleans, at mill	63.00	.....	.....	32.00	.....
Baltimore	35.00	.....	.....	36.45	.....
Cincinnati	62.50	80.00	.....	33.50	.....
Montreal	66.00	48.00	35.00	.....	45.00
Los Angeles	.....	37.00	36.00	.....	63.00
Denver	.....	30.75	30.35	.....	30.25
Minneapolis	38.50	37.25	34.25	36.00	34.75
Atlanta	17.00	.....	.....	21.00	.....
Dallas	34.00	30.00	.....	36.00	.....
Kansas City	35.00	34.50	.....	20.00	31.00
Birmingham	19.00	.....	.....	18.00	.....
Philadelphia	28.00	34.00	40.50	30.00	34.00
Detroit	42.00	33.75	.....	38.50	36.25
St. Louis	36.00	.....	.....	35.00	.....

Montreal—Up to 32 ft.; over which, $3.00 per M. increase up to 30 ft.

Birmingham—Quotes carload lots, f.o.b. sidings. $1.50 additional per M. ft. to contractor.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers prices to contractor on large projects.

St. Louis—Wholesale price to contractors, $4.50@$6 per M ft. additional.

FREIGHT RATES

On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.33½	Detroit	$0.32½
Birmingham	.76½	Kansas City	.81½
Boston	.40½	New Orleans	.51½
Buffalo	.29½	New York	.38
Chicago	.38	Pacific Coast (all rail)	1.66½†
Cincinnati	.325	Philadelphia	.35
Cleveland	.24	St. Louis	.47½
Denver	1.35*	St. Paul	.66½

* Minimum carload, 40,000 lb.

†Minimum carload, 50,000 lb., structural steel only; 80,000, lb. for other iron steel products.

CONTRACTORS' SUPPLIES

STEEL SHEETPILING—The following price is base per 100 lb. f. o. b. Pittsburgh, with a comparison of a month and a year ago:

Current	One Month Ago	One Year Ago
$2.00	$1.75	$2.55

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory — New York and East of Missouri River
Hercules red strand, all constructions	30%
Patent flattened strand, special and cast steel	30%
Patent flattened strand, iron rope	15%
Plow steel round strand rope	45%
Special steel round strand rope	40%
Cast steel round strand rope	32½%
Round strand iron and iron tiller	15%
Galvanized steel rigging and guy rope	17½%
Galvanized iron rigging and guy rope	+2½%

California, Oregon, Nevada and Washington Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¾-in., 8 ft., ¾-in., 6; ⅞-in., 4½; 1-in., 3½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0.20	New Orleans	$0.17½
New York	.17	Los Angeles	.16½
Chicago	.19	Seattle	.18
Minneapolis	.19½	St. Louis	.21
San Francisco	.17	Montreal	.30
Atlanta	.21	Detroit	.19½
Denver	.20	Baltimore	.20
Cincinnati	.20	Kansas City	.18½
Dallas	.29	Birmingham	.20½
Philadelphia	.17		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin — 40%	Gelatin — 60%
New York	$0.2950	$0.3250
Boston	.24	.275
Kansas City	.24	.2750
Seattle	.1875	.2125
Chicago	.2450	.2750
Minneapolis	.2144	.2347
St. Louis	.2475	.2775
Denver	.2250	.2550
Dallas	.29	.375
Los Angeles	.25	.29
Atlanta	.2575	.2925
Baltimore	.2550	.27
Cincinnati	.2350	.255
Montreal	.215	.255
Birmingham, *delivered*	.155	.175
New Orleans	.2725	.3075
San Francisco	.195	.23
Philadelphia	.24	.27

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.13	$0.17½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	0.17½	0.22
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	0.19½	0.24
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	0.23	0.32
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	0.25	0.34
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	0.32	0.38

SCRAP—The prices following are per gross ton paid to dealers and producers in New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$13.00	$11.50	$12.00
Stove plate	12.00	12.00	13.50
No. 1 machinery cast	18.00	16.50	14.50
Machine shop turnings	7.00@7.50	4.00	5.00
Cast borings	9.00@9.50	5.50	6.75
Railroad malleable cast	11.00	12.50	10.25
Re-rolling rails	11@11.50	13.00	15.00
Relaying rails	28.50@28.50	30.00	15.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco — Galv.	San Francisco — Black	Seattle Black
½	$6.75	$5.50	$8.55
⅝	6.30	5.05	8.25
¾	6.15	4.90	8.30

Pittsburgh base in lots of 200 kegs or more $2.50